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Water-Power Possibilities in Southeastern Alaska.*

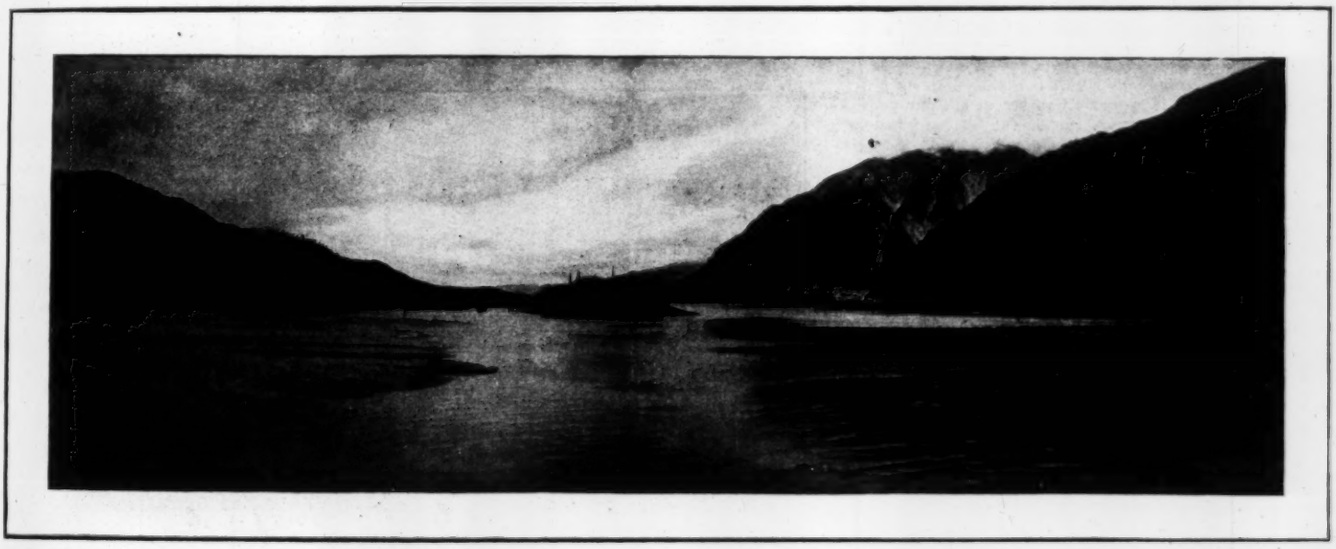
By JOHN C. HOYT,† M. Am. Soc. C. E.

General Topographic Features.

Southeastern Alaska comprises a narrow strip of main land and a series of islands separated from each other by a network of channels and straits. Both the main land and these islands are indented with many bays, fiords and inlets which, with the other natural conditions, practically cut off all travel except by boat.

With the exception of limited areas of flat lands along the larger rivers, and at places along the coast (see view on this page) the entire area is mountainous. The mountains rise abruptly from the shore line and reach a maximum elevation varying from 4,000 ft. in the southern part of the area to 7,000 ft. in the northern part. Owing to this topography, the streams, with the exception of a few of the larger rivers, which come through the mountains from the interior, have small and precipitous drainage areas (Fig. 3). Their courses are short and have a large fall; in fact, many of the streams are made up of a series of cataracts.

In the northern part most of the streams head in the glaciers which cover a large portion of the area. In the lower southern portion of the area many of the streams head in small lakes which are common to this section and occur a short distance back from the shore line in the hanging valleys which are characteristic of this area. The streams flowing from these lakes are usually precipitous, and many of them empty into the ocean with a cataract at the shore line (Fig. 2). These lakes afford excellent opportunities for storage, as the topography is usually such that a dam can be constructed for raising the water level. The most successful powers already developed depend upon such storage during a large part of the year, and further development in this region will depend upon the availability of such lakes.



GENERAL VIEW OF CITIES OF JUNEAU AND DOUGLAS, SOUTHEASTERN ALASKA.

Geology.

The general structure of the country consists of underlying rock over which there is but small depth of soil; thus the facilities for groundwater storage are exceedingly limited. The underlying rock of the insular portion of the area and to the foothills of the mainland is limestone, slate and schist; for the remainder of the area it is granite.

At the mouths of some of the larger rivers there are alluvial flats and glacial deposits. The coast line is, with few exceptions, rocky and drops into deep water close to the shore.

Climate.

As shown by Table I., the climate is similar to that of the extreme northwestern part of the United States. The last frosts occur not much later than the first of May and the first frosts do not come until early in September. The number of growing days, therefore, averages about 180.

The winter temperature ranges from 10 to 20° F., with an extreme minimum of —10° F. The maximum summer temperature ranges from 70 to 80° F., with occasional extremes of between 85 and 90°.

Precipitation varies considerably in different portions of the area. Along the west coast and in the area along Dixon's Inlet, which is exposed to the direct winds from the Pacific, it is quite high, ranging from 130 ins. at Fort Tongass to 88 ins. at Sitka. Passing inland, it decreases and at Skagway is only 21 ins.

The great drawback to the country is the large number of rainy days, which averages about two hundred, with the exception of in the vicinity of Skagway, where it falls down to less than one hundred rainy days. With few exceptions the rains are gentle and mostly in the form of mist. Notwithstanding the great precipitation, it dries off quickly after showers, which indicates that the humidity is quite low.

Vegetation.

Owing to the mild temperature, the long days in summer and the heavy precipitation, the vegetation in southeastern Alaska is very luxuriant. Except where the soil is too shallow or the slopes too rocky, the whole area is covered with dense forests of spruce, cedar and hemlock, and is in the National Forest. Among this timber there is a heavy undergrowth of devilsclub, berries and other small plants (Fig. 1). In the southern

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†Assistant Chief Hydrographer, U. S. Geological Survey, Washington, D. C.

TABLE I.—TEMPERATURE IN FAHRENHEIT DEGREES AND PRECIPITATION IN INCHES IN SOUTHEASTERN ALASKA.*

Month.	Fort Tongass. (June, 1868, to Sept., 1870.) Temperature. Max.	Min.	Precipitation. Inches.	Days over .01-in.	Fort Wrangell. May, 1868, to Aug., 1882.) Temperature. Max.	Min.	Precipitation. Inches.	Days over .01-in.	Killisnoo. (May, 1881, to Dec., 1902.) Temperature. Max.	Min.	Precipitation. Inches.	Days over .01-in.
January	47	6	12.92	18.5	47	— 4	6.07	17.6	52	— 2	5.98	18.0
February	45	23	10.79	21.5	58	2	8.11	20.0	50	—10	4.96	14.9
March	59	— 2	8.21	17.5	54	—10	2.89	12.6	52	— 2	4.04	15.0
April	60	33	9.57	10.0	64	24	4.11	16.6	63	15	3.50	11.0
May	70	38	7.70	15.5	78	35	3.71	18.6	76	24	3.38	12.3
June	75	43	6.66	10.5	86	38	3.56	13.7	76	33	2.36	9.9
July	91	52	10.58	16.6	82	44	3.69	15.8	84	38	4.19	11.7
August	81	47	6.71	9.6	84	43	3.07	14.3	81	36	4.90	16.5
September	67	38	17.66	19.3	73	38	6.63	17.2	69	27	7.79	19.3
October	58	37	14.11	20.0	67	31	7.36	13.2	60	25	7.92	22.3
November	51	32	15.46	27.0	53	4	11.27	17.8	53	1	5.16	16.9
December	47	24	13.33	19.0	52	— 3	10.41	22.5	54	1	4.81	17.6
Year	..	..	133.10	213.8	..	..	70.88	199.9	..	..	58.97	185.4

Month.	Juneau. (June, 1881, to Feb., 1897.) Temperature. Max.	Min.	Precipitation. Inches.	Days over .01-in.	Skagway. (Nov., 1898, to Dec., 1902.) Temperature. Max.	Min.	Precipitation. Inches.	Days over .01-in.	Sitka. (Nov., 1867, to Dec., 1902.) Temperature. Max.	Min.	Precipitation. Inches.	Days over .01-in.
January	50	— 4	10.61	18.1	42	— 4	0.90	7.5	51	— 2	12.17	16.8
February	50	— 4	4.85	11.2	44	— 9	0.37	2.5	54	— 3	7.47	15.9
March	59	10	6.62	18.7	63	—16?	0.64	3.0	65	— 1	6.70	18.0
April	63	13	5.25	15.0	61	16	2.39	10.5	70	19	5.61	16.2
May	71	26	7.36	16.7	79	25	0.77	4.7	80	28	4.11	16.1
June	82	38?	4.99	14.6	90	34	0.60	5.0	80	33	3.31	13.6
July	88	38	5.59	15.5	92	39	1.73	5.7	87	35	3.55	14.9
August	82	38	7.53	15.6	80	32	1.51	8.5	82	39	5.84	16.8
September	85	31	12.19	18.4	76	30	3.47	13.5	74	32	9.67	19.5
October	66	20	9.05	19.8	60	16	3.22	12.0	67	25	11.96	21.7
November	60	— 1	10.47	18.4	51	7	2.17	8.0	59	5	9.80	19.5
December	45	1	8.16	19.8	57	— 4	3.78	11.7	59	7	7.88	18.9
Year	..	..	93.06	201.8	..	..	21.75	92.6	..	..	88.10	207.9

*From "Geography and Geology of Alaska," by A. H. Brooks, U. S. Geol. Survey, Professional Paper No. 45.

part of the area trees vary in diameter up to 6 ft. and their growth extends to the mountain tops. Proceeding north, the size of the trees diminishes, the undergrowth is not as heavy, and the timber does not extend to the top of the mountains, which are usually glacier-covered.

Much of the forest is over mature, and defective timber is common, but there are many fine stands of spruce and cedar in coves and gullies for several miles back from the coast which have never been injured by fire or cutting.

The logging now in vogue takes only the best spruce trees which can be felled into the water or upon slopes where they can be skidded in by hand. Of course, it is difficult to log in a mountainous country, but much timber can be logged in southeastern Alaska with no more difficulty than attends many operations in the Pacific Coast States, if modern methods are introduced.

While so far only the spruce has been used for saw timber, both spruce and hemlock are undoubtedly good pulp woods. The few sawmills now operating in southeastern Alaska obtain their timber from the National Forest, but the supply of timber is much greater than is needed locally. The Forest Service is anxious to increase the timber sales, and the present price of stumpage is low—only $1 per 1,000 ft. B. M. Full information on this subject can be obtained from the Forest Supervisor at Ketchikan, Alaska.

Aside from the native growth, garden truck, berries and the hardy grains and grasses can be raised in all parts of this section. Strawberries, raspberries and huckleberries grow both wild and cultivated and are of a most excellent quality. Grasses and grains are hard to harvest and cure, owing to the large amount of rain.

The areas suitable for agriculture are small and are expensive to bring under cultivation. Agriculture is carried on with difficulty on account of the swampy condition of the ground, which makes it hard to work with horses unless the land is well drained.

General Conditions of Run-Off.

The run-off from the streams in this section results principally from direct rainfall, melting snow and melting glaciers. In view of the large rainfall, the excellent forest cover, and the glacial areas, the general deduction would be that this section would have many large streams with an abundant and well sustained run-off. This, however, is not the case, as the catchment areas are small and, while the total annual yield per square mile is large, the streams are not large and they fluctuate very rapidly.

The forest effects are principally overcome by the steep slopes and shallow soil, which afford but little ground storage. The streams rise very quickly after rains and fall equally as quickly when the rain ceases. In many cases they are reduced from a maximum to a minimum flow within a few days. This is illustrated in the hydrograph (Fig. 4) of Porcupine Creek,* which is situated near Haines in the northern part of the area. This stream has a drainage area of 34 sq. mi. and heads in a large glacial area.

In many places, owing to the steep slopes, there are no well-defined streams; instead, the water runs away down the mountain side in many small channels—some on the surface, and others between the soil and rock. In some of the developments the water is obtained by conduits ditches which bring the water together from the streams.

Most of the large glaciers terminate at little elevation above sea level. Therefore, they are of but practically little value as a source of water-supply for power purposes. The small glaciers are beneficial only during the summer months, as their water is cut off early in the by the frosts. It is probable that many of the extreme variations in the glacier-fed streams due to the making and breaking of ice which rise and hold back the water.

The streams which head in lakes have a better sustained flow and are practically the ones in the area which are of much value for power purposes, as any large development depend on storage both for the winter flow and during dry periods of the summer.

The principal difficulty in the water-supply from the standpoint of power is the extremely low flow during the winter months. On the smaller streams, which have no storage, there is practically no flow, and even on the streams having lake storage the flow is extremely low, as shown in the records for Turner River* (Fig. 4), which empties into Taku Inlet, near Juneau, this stream has a drainage area of 66 sq. mi. and heads in Turner Lake, which offers excellent facilities for storage. A portion of the area is also covered with glacier.

The low winter flow is due largely to the limited amount of ground-storage capacity, which freezes to bedrock, thus holding back all the water.

Industrial Conditions.

With the exceptions of a few towns along the shore and occasional mining camps and fisheries, southeastern Alaska is very sparsely settled. The only ready means of transportation is by boat and, aside from the regular steamers which

*Records furnished by the Porcupine Gold Mining Co.

*Furnished by the Alaska-Treadwell Gold Mining Co.

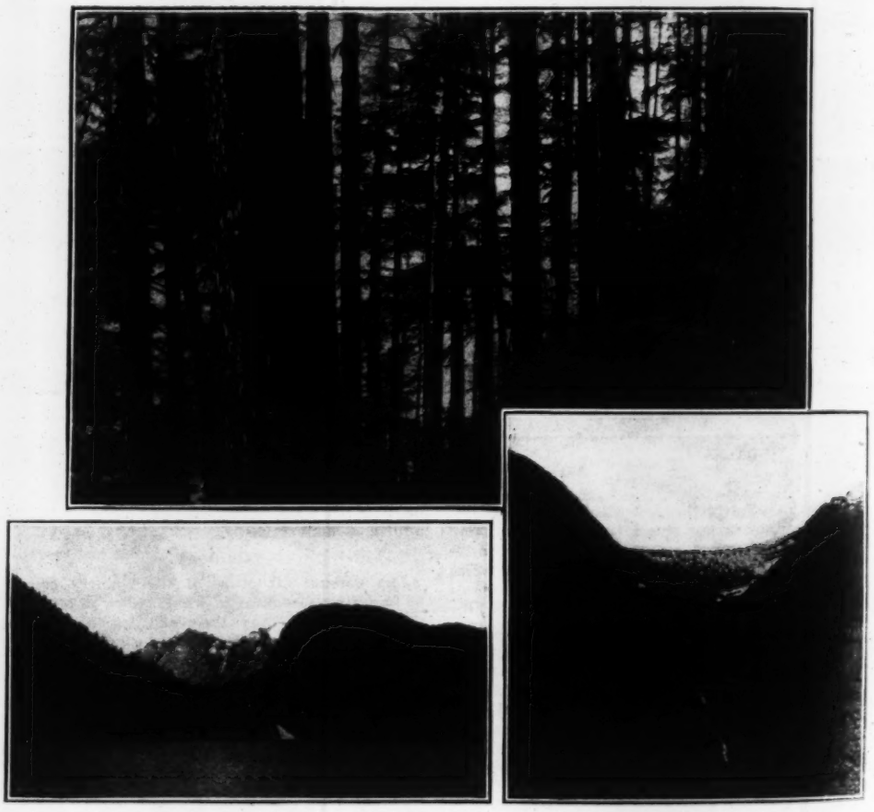


Fig. 1. Typical Forest Scene.
Fig. 2. Hanging Basin, Showing Outlet with Falls at Shore Line.
Fig. 3. Typical Drainage Area and Stream.
FIGS. 1 TO 3. FOREST, DRAINAGE AREA AND SHORE LINE SCENES IN SOUTHEASTERN ALASKA.

run from Seattle and other ports, each town has a local service with adjoining towns and camps by gasoline launches.

There are but few roads and the country back from the shore line is practically inaccessible. The building of Government roads, which is now under way, will be a great help to future development.

The two well-developed industries are fishing and mining. The larger part of the fishing is for the salmon canneries. An icing plant has just been established at Ketchikan. The mines are principally gold and copper and are mostly quartz propositions.

Next to fishing and mining comes lumbering, which at present is but little developed and is confined to shingle mills and a few sawmills which meet the local demands. Agriculture, owing to the small amount of available suitable land, will always be limited.

The success and future development both of the mining and lumbering interests depends wholly upon the ability of securing cheap power. Most of the mines so far opened have been in the Juneau belt and are low-grade properties. Large amounts of ore must be cheaply handled in order to make them profitable. The best paying mines owe their successful operation to cheap power in their immediate vicinity and their future development will depend upon the securing of further cheap power. This is a vital question with the older companies and they are investigating every possible source of power. The fishing industry demands only a small amount of power during the canning season. This can readily be obtained at small expense in the vicinity of the plants.

In developing the timber resources it will be possible to produce cheap steam power by the use of sawmill waste as fuel. The ultimate development, however, both for lumber and pulp, will be through the establishment of mills at accessible power sites.

The future development of electro-chemical processes may open a new industry for this section. In its present stage, however, it has no field in Alaska.

Practically the whole area is included in the Tongass National Forest; therefore, the conditions governing the forest reserves will, in a large measure, regulate the development of both the timber and other resources of this country.

Power Possibilities.

As shown in Table II., there were, in 1908, about 100 water wheels in southeastern Alaska, developing about 16,500 HP. This table is based on a special water-power census taken by the U. S. Census Bureau, and the amounts are made up from statements received from power owners in the various sections. These figures have not been verified, but it is believed that they are somewhat large, as they probably give the maximum development and this can be maintained only during a small portion of the year. Most of the plants have but little power during the winter months.

A great drawback to water-power development in this region is the difficulty in transmission. The country, as already stated, is cut by numerous channels, has a rough topography, and is covered with dense forests. To protect lines from damage by falling trees it is necessary to clear a wide right-of-way, which adds largely to the cost of transmission. Therefore transmission lines are difficult and expensive to construct and this practically prohibits development at sites where the power cannot be utilized at the point of development.

In considering the development of the water powers in southeastern Alaska, the possibility of developing power from lignite and coal deposits in that region must be taken into account. When these deposits are opened, fuel will probably be available at a comparatively low cost and easy water transportation will make it possible to develop steam plants near any desired point, so that taking into account the problem of transmission, steam power can undoubtedly be produced in most cases much cheaper than water power and in addition will be more reliable on account of adverse winter conditions.

The opening of any mining districts and the development of the timber interests in this section will create a more widely distributed demand for power and enable the utilization of sites which at the present time cannot be considered as available. As already stated, any larger water-power development, which can be run during the entire year, will depend upon storage possibilities. From the limited amount of topographic data available, it is likely that there may be many lakes throughout the region which will offer excellent storage facilities.

In view of these difficulties, the possibilities at the present time for large water-power development in southeastern Alaska are limited and any proposed project in this region should be closely scrutinized both as to its feasibility from an engineering standpoint and from the standpoint of a profitable investment.

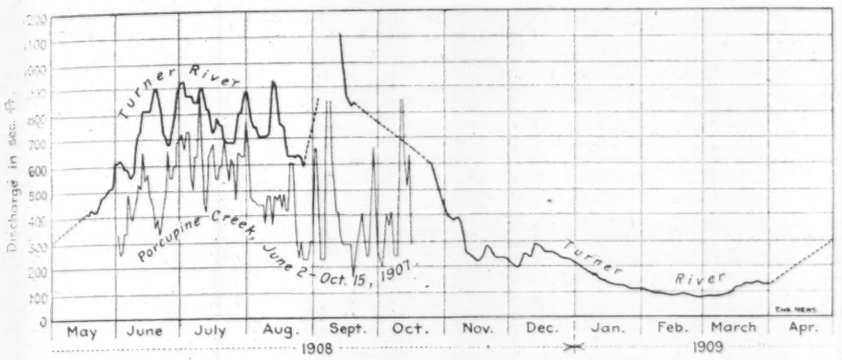


FIG. 4. HYDROGRAPHS OF PORCUPINE CREEK AND TURNER RIVER, SOUTHEASTERN ALASKA.

(It will be noted that the records were taken in different years: Turner River, nearly 12 months in 1908-9; Porcupine Creek, about 4½ months in 1907. The drainage area of Turner River is 66 sq. mi.; of Porcupine Creek, 34 sq. mi.)

TABLE II.—DEVELOPED WATER POWER IN ALASKA, 1908.

Name.	Location of plant.	No. water wheels.	Horsepower	Character of Industry.
Porcupine Gold Mining Co.	Porcupine Creek	2	50	Placer mining
Columbia Canning Co.	Haines	3	70	Cannery
Nugget Creek Mining Co.	Haines	2	24	Mining
Columbia Canning Co.	Leonard Creek	3	25	Salmon Cannery
Shakan Salmon Co.	Shakan Creek	4	150	"
Cahoon Creek Placer Co.	McKinley Creek	2	100	Placer Mining
Union Iron Works	Gold Creek	1	8	Machine shop
Hydraulic Pipe & Boiler Works	Juneau	1	8	Pipe & Boiler Works
Finn & Young	Shakan	1	25	
Wm. Duncan	Metlakatla	2	53	Saw Mill & Salmon Cannery
R. G. Ketchum	Kupreanof Island	1	50	Barrel Factory
Alaska Industrial Co.	Jumbo Creek	1	150	
"	Sulzer	1	30	Mining
American Gold Mining Co.	Sheep Creek	3	80	"
Yukon Publishing Co.	Skagway	1	3	Newspaper
Home Power Co.	Lake Dewey	1	125	Light and Power
New England Fish Co.	Lake Whitman and Gold Creek	4	4,000	Fish freezing and ice making
J. P. Jorgenson & Co.	Juneau	4	25	Lumber
Ebner Gold Mining Co.	Gold Creek	4	4,000	Quartz mining
Alaska Perseverance Mining Co.	Silver Bow Basin	8	880	Mining
Alaska-Juneau Gold Mining Co.	"	2	500	"
P. H. Partridge	Hoonah	2	15	Sawmill
Alaska-Copper Co.	Lake Creek	4	300	Smelter & Sawmill.
A. Murray	Douglas City	2	5	Wood turning, etc
Juneau Iron Works	Juneau	1	6	General repairs.
Treadwell group	Douglas Island	37	6,297	Gold mining
Alaska Water, Light & Telephone Co.	Solomon Gulch	1	350	Light & Power Co.
Seward Light & Power Co.	Resurrection Bay	1	150	"
Citizens' Light, Power & Water Co.	Ketchikan Creek	2	240	"
Alaska Electric Light & Power Co.	Gold Creek	5	1,000	"
Tanana Electric Co.	Chatanika	1	500	"
Chichagoff Gold Mining Co.	Clay bay	1	150	"
	Total	103	16,469	

The Educational Bureau of the Union Pacific R. R.*

By DEXTER C. BUELL.†

In the face of the general increased cost of living, increase in wages of employees, shorter hours of labor, higher prices of materials and supplies for maintenance and operation, and stationary or reduced freight rates—conditions all of which are beyond the control of the railroad executive, it becomes necessary to consider every plan which may seem to offer a means of operating his property more economically.

In only three of four directions is it now possible to make appreciably large economies. The executive must endeavor to reduce operating expenses through (1) fuel economies, (2) tonnage economies, (3) reduction of accidents and claims, (4) increasing the efficiency of officials and employees. It should be noted that the realization of the first and third conditions depends on the accomplishment of the fourth; and that aside from the consideration of capital expenditures for heavier power or grade reductions, economies under the second head also depend on the fourth. The opportunities for realizing more efficient and economical railroad operation depend to-day largely on the railroad manager's ability to increase the efficiency of his officials and employees.

THE AIM OF THE BUREAU.—Realizing these truths, the Union Pacific R. R. looked this problem square in the face a year and a half ago and set itself the task of accomplishing results along the line of increasing the efficiency of its officials and employees. The result was the establishment of what, for want of a better name, was called The Educational Bureau of Information.

Several fundamental business principles were kept constantly in mind. (1) Loyalty and efficiency go hand in hand. (2) To create loyalty employees must know and be made to feel that the company is interested in their welfare and success. (3) To make them know this, promotion of those in the service must be made—seniority and ability both being considered. "Outsiders" must not be put over the heads of loyal and able employees. (4) Means must be devised and provided whereby ambitious and loyal employees may have opportunity to become better informed concerning their work and the work of the position ahead of them for which they are ambitious to qualify for promotion.

The Union Pacific realizes these fundamental principles. It never goes outside of its ranks to fill vacancies if any competent employee can be found for promotion; offers aid to the ambitious, so that they can fit themselves to clasp the hand of opportunity if it is offered to them; and tries to give a "square deal" to every man in the service.

The Educational Bureau was organized Sept. 1, 1909, with three stated objects in view: (1) to assist employees to assume greater responsibilities, (2) to increase the knowledge and efficiency of employees, (3) to prepare prospective employees to enter the service. [See Eng. News, Oct. 7, 1909.—Ed.]

The idea of educating one's employees is not a new one,

*Extracts from a paper before the Central Railway Club, Buffalo, N. Y., Nov. 11, 1910. The establishment of this Bureau was described in Engineering News, Oct. 7, 1909.

†Pacific Express Bldg., Omaha, Neb.

although until the Union Pacific started this work, railroad educational plans were outlined for employees in but one or two lines of work—principally shop apprentices, or employees of the mechanical department. All of these educational plans left out of consideration entirely numerous other classes of employees in the service. Many plans made it compulsory on the employees to take up the work. Without exception, these systems have proved so expensive, no matter what the results may have been, that their dividend-paying possibilities have been questioned.

In organizing the Union Pacific Educational Bureau, it was decided that, if we were to assist employees to assume greater responsibilities, such assistance must be extended to every man in the service that desired it, no matter what his position or occupation might be. It was further decided not to make it compulsory upon any one to take up this work, and to so devise and operate the scheme as to keep the expense so low that no question could be raised as to the benefits more than offsetting the expense. It was decided that the only way to reach all employees with equal effectiveness and to insure to every man the opportunity to take advantage of this offer, was to give the instruction according to methods of successful correspondence schools. The strong points and weak points of present correspondence-school methods were weighed; the strong points were strengthened, and the weak points eliminated as far as possible.

PREPARATION OF TEXTBOOKS.—The almost utter lack of textbooks, or publications that could be used as textbooks, on general railroad matters, was realized, and the task of preparing a set of lesson papers to cover the various lines of railroad work was begun at once. It was decided that no instruction papers should be issued unless approved by the head of the department interested, and that all educational matter issued by the bureau should deal with Union Pacific practices and methods, thus assuring the student that what he studied and learned through his educational course could be put into practice immediately.

In order to make sure that the bureau's work was being done according to Union Pacific practices, an advisory board, consisting of the head of, or a representative of the head of, each department, was organized. This board met with the Chief of the Bureau each week to plan the work, outline the courses, and direct the policy of the bureau. When the course outlines were prepared and divided into subject headings, each subject was assigned to the employee or official on the system who was considered best qualified to write authoritatively on it, and he was requested to prepare on that subject a paper, to be submitted to the Chief of the Bureau. When a series of papers was completed, the various men who had written these papers were called in to the bureau headquarters, thus forming a committee before whom the papers were read, discussed, and criticized. Following this general discussion, the papers were returned to the writers for such revision and correction as were suggested, and finally sent to the Bureau. Such papers usually contained all the obtainable facts relating to the subject treated of, the Bureau's work being to arrange these facts in such order that they would be suitable for instructional purposes; to get pictures to illustrate them; to edit them; and to issue them. In keeping with these duties, day by day at the bureau headquarters, the unwritten laws and practices of railroading are being gathered and put into textbooks; existing rules are being systematically compiled, condensed, explained, and illustrated; departmental work is being taken up from the simpler beginnings, and being explained through the various steps to such limits as may seem desirable.

Complete courses are being written on such subjects as there is the greatest demand for. Other subjects or special lines of work, on which information is desired by only a few of the employees, are being covered by special instructions; or, possibly, by transferring the employee to a department or position where he can gain the information desired through practical work, with the cooperation of the bureau.

A list of the courses offered to employees at the present time may be of interest, and is as follows: (1) Block Signal Maintenance and Operation, (2) Interlocking, (3) Signaling, (4) Elementary Electricity, (5) Electric Light and Power, (6) Telegraphy, (7) Telephony, (8) Railroad Operation, (9) Train Operation, (10) Station Work, (11) Railroad Accounting, (12) Freight Traffic, (13) Passenger Traffic, (14) Analysis of Statistics, (15) Track Work (in English), (16) Track Work (in Japanese), (17) Surveying and Mapping, (18) Railway Civil Engineering, (19) Railway Mechanical Engineering, (20) Locomotive Course, (21) Air Brake Course, (22) Gas Engines, (23) Motor Cars and Motor-Car Operation, (24) Mechanical Drawing, (25) Sheet-Metal Pattern Drafting, (26) Boiler Construction and Repairs, (27) Machine Design, (28) Refrigeration, (29) Car Building, (30) Car Repairing, (31) Shop Practice and Plumbing and Pipe Fitting. Other regular courses may be added as demanded.

In order to keep employees up-to-date on improvements or new methods, arrangements have been made to issue special pamphlets on any live subject of interest, whenever it is deemed expedient. Such special pamphlets are in a series by themselves and are distributed to all employees interested, whether students of the bureau or not.

In order to take care of students who are deficient in mathematical training, a series of mathematical papers has been specially written to help students over any mathematical difficulties they may encounter in their lessons. For example: A student taking the Gas-Engine Course may come across a problem in square root that he is unable to solve. Instead of starting this man on elementary mathematics, and making him take complete training until he reaches and completes square root, an instruction paper of six or eight pages has been prepared on the subject of square root alone, and can be mastered by any one who can add, subtract, divide and multiply. In the same manner, a paper on Formulas has been prepared, and will enable any one with the barest knowledge of addition, subtraction, multiplication and division to understand and manipulate any formulas met with, either numerical or algebraic.

An important part of the training of all employees is to familiarize them with the property for which they are working. With this end in view, a series of papers has been prepared, embracing the history of the Union Pacific, general information regarding its organization, and the scope of the organization of the various departments, and a geography of each of the states in which its principal mileage is located.

When possible, existing textbooks are used. For example: The Mechanical-Drawing Course of the Scranton schools is undoubtedly as good as can be obtained on the subject, and is used for our work. There are few textbooks, however, that can be so used.

To take care of the eight or nine hundred Japanese laborers employed, from 60 to 70 of whom are section foremen, the Track Course has been translated into Japanese and issued to these men—nearly 25% of all Japanese employees on the pay-roll being students of the bureau, in good standing.

An unusually efficient photographer is attached to the staff of the bureau, and, after an instruction paper is written, he familiarizes himself with what must be taught the student, and goes out on the road and takes such pictures as are necessary to properly and helpfully illustrate the lesson.

The lessons, when prepared, are furnished to the students in the regular manner; that is, a pamphlet containing instructions on how to study is sent out, together with the first lesson of the course requested. All lessons contain a list of examination questions. Answers are sent to the bureau, graded, and returned to the student. The bureau is very liberal in allowing the employees to take up practically any course they desire, although it prefers that a course, applying to the line of work that a man is engaged in, be taken. The examination questions on the lessons are asked in such a way as to require a maximum of studying, with a minimum of writing, the desire being to furnish the information, and to have it absorbed, without compelling the student to spend any more time than is necessary in writing out answers. This also reduces the office force necessary to handle the correction of the papers.

TRAINING MEN FOR PROMOTION.—Men who desire to engage in another line of railroad work than that in which they are employed, are, under certain conditions, assisted in making transfer from one department to another, although this transfer must be made with the approval of the heads of both departments interested. In order to take further advantage of the good which the bureau may do, the Operating Department has arranged that, in certain cases where men are selected for promotion, they will be given special training at the company's expense, to fit them to enter upon the duties of their new position; this is done before the promotion is announced. For example: A trainmaster, selected for promotion to the position of Assistant Superintendent, has been given a year's training at the expense of the company, and has been paid during this training period, the salary he was drawing when selected for promotion. This man came from the ranks, served as brakeman and conductor, and was in station service before being promoted to trainmaster. He was given three months' experience in the Track Department, served as laborer and assistant foreman, did the manual work under the direction of a selected foreman, and at the same time, studied special information on track work, supplied from the bureau. He was then put into the position as handyman at the shops and served three months in the Motive Power Department—with an erecting gang, breaking in engines, in the roundhouse as a handy-man, and in the air-brake, lubricator, and injector repair departments. He was then given special training in the Store Department, relating to material and supplies; and is finishing his training in the Accounting Department, spending a few weeks in each of the various sub-departments under the direction of the several auditors. He may go back into service at the completion of his term of training as a trainmaster; but, we have available, whenever wanted, a man who can step into the position of Assistant Superintendent, thoroughly familiar with our methods and practices, and ready to travel at full speed from the day he assumes the position.

From two to six men are constantly under special training, being selected from clerical positions, from station agents, or from the Operating Engineering, or Motive Power Departments, according to the recommendation of their superior officers—the men selected having shown by their loyalty, their attention to duty, and their work, that they are entitled to consideration and promotion. Such men are handled by the Operating Department, and the expense of their training is borne by the Operation Department—not by the Educational Bureau.

In order to reach a large class of men who might desire to take up a special course of training systematically, but who desire information from day to day concerning points that arise in their work, the Educational Bureau gives any employees the opportunity to ask any questions they may desire about their work or about railroad work in general. Such questions are either answered through the Bureau direct, or, if necessary, referred to the department envolved. All answers are reviewed by the Advisory Board before being sent out to the students, thus insuring the accuracy of the information and preventing any complications from arising due to questions of discipline or legal matters.

AN EMPLOYMENT BUREAU.—In establishing the Bureau, the fact was recognized that an important factor in efficient organization was to get as good a class of men as possible to enter the service. For that reason, the Bureau conducts an employment bureau on a very small scale. It receives applications from any one anxious to enter Union Pacific service, and all officials are free to call on the bureau for men to fill vacancies, if they so desire. The Bureau furnishes the best available material on hand, if there are any suitable applicants registered. In many cases, where vacancies are open that are in the nature of promotion positions, instead of positions at the bottom of the ladder, as in the previous case, a request will be sent to the Bureau asking if there are any students who have shown such proficiency in their work as to make them available for promotion. In this manner, a considerable number of men have been supplied for positions which were of the nature of promotions, who otherwise would have remained unnoticed in the service, while the vacancy would have been filled with an "outsider."

A school has been established at the Bureau headquarters, for the purpose of training men to enter station service, with the exception that they will later qualify as operators or station agents. This station training school does not teach telegraphy, but accepts applicants who have had telegraph training and can receive from 18 to 20 words per minute. The school room is equipped similarly to a medium-sized station, and is under the charge of one of our successful station agents. All railroad wires are cut into the school. The standard forms, tickets, baggage checks, etc., are used, and a four-weeks' course of study is outlined. This starts the student on the bill of lading and waybill, and carries him through the tariffs, teaches him rates and classifications, ticket business and baggage business, mail and express business, car reports, and in fact all the simpler work a station agent is called on to do. Several hours each day are allotted to practice on the telegraph wires; and all station helpers for the system are suplied from men who have gone through this school. Previous to the establishment of this school there were furnished in one year for the Union Pacific system, 530 station helpers, of whom 60% left the service within a few months of the time they were hired. Since the establishment of this school, but 4% of the helpers furnished have left the service, and numerous promotions of the station-school graduates have been made. Several men, who had never had any experience but their telegraph-school training, have been promoted to positions as telegraph operators within three weeks after leaving the station school.

GENERAL RESULTS.—The Bureau is just a little over a year old. A great deal of preliminary work has had to be done in preparing courses and working out methods. No attempt has been made to get students for the bureau. Practically all that has been done has been to announce that such a bureau has been established and is open to employees. Over 1,600 employees have voluntarily asked for assistance; of these, 80% have made good, that is, are studying and are in good standing with the bureau. Almost every man taking advantage of this work expresses his appreciation of what the company is offering him, by saying that he will try to pay for it by doing better work. It is producing the spirit of loyalty desired, and is increasing the efficiency of those men who are taking courses.

The progress of the work is such at the present time that a general campaign will soon be made to acquaint all the employees of the benefits offered by this Bureau, and it is expected that, without doubt, the enrollment can be increased four or five fold with little effort. The expenses have been remarkably low; so low, in fact, as to leave no doubt in the minds of our officials that the investment has been an exceptionably good one. It has put new life into a large number of men, who previously saw no opportunity to get out of the rut they were in, and is building up a class of men from whom will come our future officials.

Extracts from the Annual Report of the Isthmian Canal Commission for the Year Ending June 30, 1910.

DESIGN OF LOCKS AND DAMS.—The first division of the office of chief engineer, under Lieut. Col. H. F. Hodges, assistant chief engineer, continued in charge of the design of the locks, dams, regulating works, and accessories. The general features of the intermediate and lower locks at Gatun and the flight at Miraflores have been adopted.

As it was concluded that an approach wall in prolongation of the wall separating the twin locks should be provided against which vessels should moor, and that the wing walls of the locks should not be utilized for this purpose, designs for the approaches have proceeded along these lines. The south approach wall at Pedro Miguel was designed of massive concrete, and the larger part of it is constructed. The northeast wing wall will also be of massive concrete, and reinforced-concrete walls have been designed for the northwest, southeast, and southwest wing walls in the same locality.

A contract was entered into on March 2, 1910, for all the frames for the gate valves required to control the main culverts for the upper Gatun and Pedro Miguel locks, and the delivery of the material began before the close of the fiscal year. A contract was entered into on July 10, 1909, for the frames and moving parts for two sets of Stoney valves; up to the close of the fiscal year but little of the material had been delivered.

Forty cylindrical valves were contracted for on July 10, 1909, the number required for the two sets of locks under construction. About 90% of the contracted material has been delivered. Experience gained under contracts for the cylindrical valves brought about slight modification of the designs, by the substitution of cast iron for steel, and by changing the section of certain parts. Bids have been asked for furnishing the remainder of the ironwork required for all the valves for the main and lateral culverts, except the movable parts of the Stoney valves, which will not be purchased until the work is further advanced.

During the fiscal year, such general and detailed drawings of the lock gates as were necessary to advertise for all the gates required to fully equip the locks were completed. The advertisement issued on April 18, 1910, and bids were opened for delivery of the material and for erecting the gates in place. The lowest bid, that of the McClintic-Marshall Construction Co., Pittsburg, Pa., was accepted, and a contract made with this firm. The prices are 3.785 cts. per lb. for structural steel erected, 2.62 cts. per lb. for structural steel not erected, and $5,374,474 for the entire work. The advertisement called for the erection complete of all the gates in the canal, 46 in number, or 92 leaves, by Jan. 1, 1914. Barring strikes and other accidents beyond the control of the contractors, the McClintic-Marshall Construction Co. bind themselves to complete the work by June 1, 1913. Under the contract the work of erection at Gatun is to begin on Jan. 1, 1911, and to be completed on Feb. 1, 1913; at Pedro Miguel the work of erection is to begin March 1, 1911, and to be completed May 1, 1912; and at Miraflores work is to begin Jan. 1, 1912, and to be completed June 1, 1913. Arrangements will be made to have the concrete work completed to meet this schedule.

The design of the machinery for operating the Stoney gate valves for the main culverts has been completed in detail. The valves will be operated electrically, and the machinery is arranged for either local or remote control, auxiliary hand apparatus being provided to close the gates should the machinery fail when a valve is in the raised position. The machinery for operating the cylindrical valves, of which there will be 120 in the six twin locks, is complete in all its details. In order to try out the machinery as designed, before purchasing the large number required, specifications have been prepared and bids invited for two machines of each class.

Much study has been given to the question of the machinery for operating the gate leaves. As the result, the recess in the wall into which the leaf fits when open was modified so as to permit of freer exit of the water around the miter post when the gate is near the position of rest, and a type of machine was adopted in which the force applied increases and the rate of motion decreases near the beginning and end of the movement. Briefly, the machinery adopted consists of a rigid horizontal strut connected to the upper girder of the gate leaf. The other end of the strut is attached to a large horizontal gear wheel near its circumference. As the large gear wheel is turned, the effect upon the strut is practically that of a crank upon a connecting rod. The rate of travel of the gate increases gradually from the beginning to a point just beyond the middle of the path between the recess and the miter. After passing its maximum, the rate gradually diminishes until just at mitering it becomes very small. It has been thought desirable to provide on the gate leaves a positive lock which will hold them together against wave action, and at the same time it has seemed possible to arrange a locking device which will force the gates to meet perfectly at the miter, thereby reducing the care which is usually necessary in closing large lock gates to avoid a false miter. The device adopted is a new one and will be tried carefully before being extensively applied.

The general design for the spillway dam at Gatun was completed. The cross section of the dam is an ogee, made up of an arc of a parabola, a tangent, and the arc of a circle, the parabola being such that when the stream flowing over the crest is 6 ft. or more in depth the nappe will adhere to the downstream face of the dam.

The trace of the dam is a semicircular arc, which secures not only the necessary development of crest, but also partial neutralization of the energy of the converging stream that will flow over it. To still further destroy the energy, two rows of baffle piers are placed on arcs of circles concentric with the dam. The crest of the dam is divided into 14 bays 45 ft. wide, by 13 piers and 2 abutments, closed by means of Stoney gates operating on trains of live rollers moving on castings set in the piers. With the lake at +87, one bay with the gates fully opened will discharge 11,000 cu. foot-seconds, and all 14 fully opened will discharge about 154,000 cu. foot-seconds, or a greater amount than the maximum known discharge of the Chagres River continued during a period of 33 hours, which is 137,500 cu. foot-seconds at Gatun. Since the coping and top of the gates at upper Gatun and Pedro Miguel locks have been placed at +92, it would require a rise of 5 ft. in the Gatun Lake to do material damage, and as it would take the maximum continued discharge of 137,500 cu. foot-seconds 9 hours and 20 minutes to raise the level of the lake 1 ft., were no gates of the spillway opened during this time, ample provision has been made to take care of the floods that may occur, even should there be any negligence or delay in the operation.

As the spillway channel must be used for the discharge of the Chagres during the building of the main dam, the construction of the spillway dam will be one of the last parts of the work completed, and special means must be provided to permit its construction during the rising in the lake. Piers about 20 ft. apart have therefore been built from the foundation projecting above low water, and of such design that stop planks can be placed between them, thus forming a cofferdam, under the protection of which concrete can be placed. The design also contemplates the construction of four low-level culverts, three of them regulated by Stoney valves, and the fourth by a cylindrical valve, all like those to be used in the locks. These culverts will be installed probably during the next dry season, and by their aid the lake level can be regulated during the construction of the remainder of the dam, the concrete being kept ahead of the slowly rising lake surface. The culverts will subsequently be filled with concrete.

The general plan of the machinery to be used in raising and lowering the Stoney gates on the crest of the spillway has been prepared. The machinery will be mounted in a tunnel in the main body of the dam for the purpose of protecting the parts of the machinery and the counterweights, this arrangement at the same time obviating the installation of cumbersome and heavy material on the footbridge which extends over the gates.

A design has been prepared for an electric locomotive, which it is thought will prove satisfactory to tow vessels through the locks and have full control of them from the time they approach until they are locked through to a point beyond which they can proceed under their own steam.

Work on the movable or emergency dams, the preliminary design of which was given in the last annual report, has been continued during the year, the various details settled, and the necessary drawings are now being prepared on which to invite bids for the delivery of material and erection in place.

Investigation of the expenditure of water from Gatun Lake as affected by the design adopted for the locks has been carried on during the past year. The results indicate that during ordinary years there will be a considerable surplus of water, even in the dry season, and that the water supply of the worst-known dry season for the last 19 years, namely, that of 1908, would be sufficient to maintain through the canal an average daily number of passages three or four times as great as the average number now passing the Suez Canal. This after making reasonable deductions for evaporation, leakage, power supply, and lockages.

The arrangement of the lifts in flights at Gatun and Miraflores increases somewhat the expenditure of water over what it would be were the locks separated into single lifts. The tidal effect at Miraflores also increases the expenditure considerably at that place. Nevertheless, the water supply is ample for the canal as planned, and a separation of the locks into single lifts would have carried with it a great increase in expense to bring about an unnecessary saving in the water supply.

GATUN SPILLWAY LOOKING NORTH, SHOWING CONCRETE PIERS AND GROOVES FOR STOP LOGS.

GATUN SPILLWAY LOOKING NORTH, NEAR RAILWAY BRIDGE SHOWING CHAGRES RIVER FLOOD PASSING DOWN SPILLWAY.

Atlantic Division.

The work is in charge of Lieut.-Col William L. Sibert, Corps of Engineers, U. S. Army, as division engineer.

GATUN LOCKS.—The work of excavating the locks was continued during the year by steam shovels, and to some extent by dredges, resulting in the removal in lock chambers of 3,965,699 cu. yds. in the dry and 435,178 cu. yds. in the wet. In addition to this work excavation, there were removed 646,520 cu. yds. of material in auxiliary work, including dredging in the French canal. The excavation in the upper locks was completed, including the trenching for the curtain walls and for the lateral culverts in that portion where these culverts were below the excavated area. With the exception of the trenching required for the lateral culverts, the excavation for the intermediate locks was completed. The excavation for the lower locks, exclusive of the approach walls, was also undertaken, and 375,000 cu. yds. remain to be removed. The average cost of the excavation for the past six months, including plant charges and division expenses, was $0.6751 per cu. yd.

At the close of the fiscal year 1909 the unloading cableways were in partial operation, and the erection in progress of the balance of the plant, which is described

in the annual report for 1909. During the year the entire plant was completed in time to permit laying of concrete on August 24. The unloading cableways were unable to stand the strain required by operating them continuously at the speed necessary to secure the capacity called for in the specifications, and slight modifications were made to reduce the speed. Certain structural weaknesses in these and the lock cableways also developed, which were subsequently remedied.

The unloading plant has been operated 24 hours per day since April, when the searchlights were installed. The quantity of material handled was 2,458 cu. yds. of large rock, 358,665 cu. yds. of crushed stone, and 155,458 cu. yds. of sand, of which the unloading cableways handled 314,854 cu. yds. of crushed stone and 138,813 cu. yds. of sand. The greatest output was in June; during this month the unloading cableways, five strands, handled 64,797 cu. yds. of material, of which 22,521 cu. yds. were sand. Operating on the basis of 24 hours per day, 48.65% of the time was consumed in actual unloading operations, the balance lost waiting for barges (29.50%) and in other delays (21.85%); in other words, these cableways averaged 21.6 cu. yds. per hour while in the service, or 44.33 cu. yds. per hour of actual time in unloading. During the same month two derricks operating on the basis of 24 hours per day unloaded 25,400 cu. yds. of crushed stone from the barges to the bins, or an average of 20.5 cu. yds. per hour per derrick.

Difficulties were encountered with the automatic cars, due to lack of stability of the motor mounting, which set up a vibration and caused such excessive strains on the driving chains as would result in early destruction. This was remedied by extending the motor support and raising it by means of bearings on the axle. Due to the narrow gage and lack of clearance, the king pin of the truck is high, resulting in occasional derailments when the car was started, and an extra guard rail was placed where the most frequent derailments occurred, thereby eliminating the trouble.

Cement deliveries under the contract with the Atlas Portland Cement Co. commenced in July, 1909, and with the cement shed full, the difficulties met with in the operation of the plant caused the supply to accumulate faster than it could be used. Rather than stop the deliveries, instructions were issued to lay as much concrete as possible, even at increased cost, and for the erection of an auxiliary plant, not only to increase the output of concrete sufficiently to care for the deliveries of the cement, but as an auxiliary to the plant in case of similar or other breakdowns. Work was prosecuted daily, including Sundays, until November, when Sunday work was discontinued. On Sept. 6 a 12-hour day for the permanent plant was instituted, and continued throughout the year.

The auxiliary plant consists of two 2-yd. mixers similar to those used in the permanent plant, but steam driven. Material is handled from the cement shed and stock piles to the bins above the mixers by standard railroad equipment. The product of the mixers is handled by narrow-gage locomotives with cars, the latter being small side dumps when concrete is placed in the floors, and platform cars holding from two to four 2-yd. buckets when concrete is placed in the walls. In the latter case derricks are used in connection with this plant. It was installed, began operations in December, and has continued since on the basis of an eight-hour day.

The permanent plant laid, to the close of the fiscal year, 409,381 cu. yds., including large rock placed in the concrete, and the auxiliary plant, 104,422 cu. yds., or a total of 513,803 cu. yds. The total amount of concrete to be placed in the Gatun locks, including the approach and wing walls, is estimated at 2,046,100 cu. yds., so that the total amount remaining to be placed is 1,532,297 cu. yds.

The largest amount of concrete laid in any one month was in June, when a total of 89,869 cu. yds., bucket measurement, was reached. The permanent mixing plant had six of its mixers in use operating, theoretically, twelve hours per day, excluding Sundays, and in actual operation for an average of 11.82 hours per day. The number of cubic yards mixed was 62,202 or an average of 32.4 cu. yds. per mixer per hour. The auxiliary-plant mixers operated eight hours per day excluding Sundays, and mixed 23,390 cu. yds., or an average of 56.73 cu. yds. per mixer per hour. The lock cableways, consisting of 8 strands, averaged 12.59 hours per day, excluding Sundays. Of this time, 79.8% was in laying concrete, 7.1% setting steel and forms, 0.24% removing excavation, 2.62% in moving, 1.3% in repairs, and 8.94% in delays. The actual number of cubic yards of concrete and large stone laid by the cableways was 66,479, or an average of 31.42 cu. yds. of masonry per strand per hour at work. The average cost of the concrete per yard in place for the year was $7.355, including plant charges and division expenses.

With a view to reducing the cost of concrete, instructions were issued in November to make arrangements to embed large stone, not less than one-man size, in the masses of concrete, and to an amount of about 20% of the mass. This was begun in March, and up to the close of the year aggregated a total of 10,786 cu. yds. The stone was selected from material shipped from the central division for use in constructing the toes of the dam, and 2,458 cu. yds. of large stone were procured from the Porto Bello quarry in May and June. On account of the excessive cost of the latter, $6.284 per cu. yd. delivered at the locks, this source of supply was abandoned.

Collapsible steel forms are used throughout for the main and lateral culverts, and steel tower forms, which were purchased and erected under contract and are in place, are used for constructing the side and center walls.

STONE AND SAND.—Crushed stone for the concrete of the locks and spillway was obtained from the Porto Bello quarry, which was developed during the year with a single face having a length of 2,500 ft. and a maximum height of 140 ft. Considerable delay is occasioned by the fact that a large amount of "dobying" is required to handle the blasted material to and from the cars and to feed the No. 9 crusher—the largest installed as yet. To overcome this, and to increase the output, a No. 21 crusher was ordered in November, and is under erection. It is so placed that its entire product will be raised to the two No. 9 crushers, through which it will pass. The twelve-hour working day was increased to 16 hours on Dec. 27 by operating two 8-hour shifts, and this was continued during the remainder of the year.

The total amount of stone quarried and crushed was 549,678 cu. yds., at an average cost for the last six months of $2.6283 per cu. yd. delivered in the stock pile at Gatun, this cost including plant charges and division expenses. The greatest month's output was in June—a total of 74,184 cu. yds.—when the plant for 70.15% of the time, excluding Sundays, was engaged in crushing, 19.72% undergoing repairs, and 10.13% not working, waiting for barges and on account of other delays. The output of the crushers averaged 176.3 cu. yds. per hour in service, and 251.3 cu. yds. per hour crushing.

Sand was obtained from Nombre de Dios and from the Pacific division. The total amount of sand obtained from Nombre de Dios amounted to 187,183 cu. yds., at an average cost for the last six months delivered in stock pile at Gatun of $1.9153 per cu. yd., including plant charges and division expenses. During the year, 101,748 cu. yds. were transported from Balboa docks in the Pacific division and delivered in the stock pile at Gatun, at a total cost for the last six months of $1.2488 per cu. yd.

GATUN DAM.—Prior to January, 1910, the operations in the construction of the dam were practically limited to that portion between the locks and Spillway Hill. It was decided in January that a larger amount of the material for the toes of the dam should be procured from the central division, this supply to be utilized so long as it could be economically furnished, and that such material should not be selected and confined to Bas Obispo rock as formerly, but should be run of the excavation. To accomplish this an additional number of steel dump cars were ordered to provide the necessary facilities for furnishing the largest amount of material that can be economically handled at the dam.

The discharge of the Chagres River was through the west diversion, and so continued until April 25, when the work in the spillway had been sufficiently advanced to permit of its use for this discharge. Efforts were then concentrated toward filling in the toes crossing the west diversion. Due to the fact that the rainy season had already set in, and that the bottom of the channel eroded as the opening narrowed, some minor slips occurred, but none of importance.

At the close of the fiscal year, the north and south toes of the portion of the dam east of Spillway Hill had reached an elevation of 65 ft. above mean tide, and the hydraulic fill between the toes, an average elevation of 51 ft. West of Spillway Hill the north toe had been carried to an elevation of plus 30, and the south toe to an elevation of plus 35. Three dredges were pumping hydraulic fill into the west section, two from the south side and one from the north, and a fourth dredge, delivered under contract June 28, was put on the east portion of the dam, but will soon be removed to the west side of Spillway Hill until the hydraulic fill in the west portion is sufficiently high. The total amount of material placed in the dam during the fiscal year was, dry fill 2,577,234 cu. yds., estimated on car, or place measurement plus 25% swell, and hydraulic fill 2,933,175 cu. yds., estimated on borrow pit measurements, less losses ascertained by cross section when practicable. The average cost for the last six months of the year for the dry fill, including plant charges and division expenses, was 28.19 cts. per cu. yd.; for the wet fill on the same basis, 32.54 cts. per cu. yd.

Auxiliary work consisted in preparing the west valley for the reception of the hydraulic material by clearing and stripping off the top soil containing roots, excavating a cut-off trench along the axis 10 ft. wide and varying in depth from 5 to 10 ft., and a bonding ditch along the foot of the western ridge. The surface of the low-lying areas was plowed. This preparatory work required the excavation of about 112,000 cu. yds. over an area of 62 acres. An area of 138.45 acres south of the dam over which the dredges will operate in securing the interior fill was thoroughly cleared and grubbed. An area of 51.36 acres to the north of the dam was cleared for the same purpose. Trestles aggregating 7,486 ft. in length were constructed during the year.

Excavation for the spillway was continued during the year, resulting in the removal of 127,210 cu. yds. The excavation for the foundation of the spillway dam was completed, except at the extreme end; that for the certain and side walls and for the floor was fully completed. Work on the floor and the side walls was continued, 56,632 cu. yds. of concrete being placed, at an average cost for the last six months of the year, including plant charges and division expenses, of $8.[illegible] per cu. yd. By April 25 the side walls, floor, and certain walls were completed, and the foundation of the dam sufficiently advanced to warrant turning the Chagres River through the spillway. Considerable time was lost owing to the excessive floods of November and December. As the foundations of the dam are placed at elevation plus 10, and the other channels of the river cut off, the lake has been backed up so that its surface stands at from 16 to 20 ft. above sea level.

Material is carried to the toes on the west portion of the dam by trestles in prolongation of these toes, across the channel through the spillway; as the trestles are liable to be carried out during the flood season, a permanent bridge across the spillway was constructed, consisting of six spans on concrete piers. The central truss, 100-ft. span, formerly carried the old line of the Panama Railroad across the Gatun River.

CHANNEL BETWEEN GATUN LOCKS AND THE ATLANTIC OCEAN.—Excavation in the dry in the Mindi section was continued until Nov. 20, when work was suspended due to the cut being filled by the high water in the Chagres River, which had access to the French canal. There were excavated in the dry 91,572 cu. yds. of earth, and 233,144 cu. yds. of rock at an average cost of 62.18 cts. per cu. yd., including plant and division expenses. The deepest part of the cut had reached a depth of 42 ft. below sea level at the time work was suspended.

The six dredges in operation between the Mindi Hills and the Caribbean removed a total of 4,556,375 cu. yds. of earth, and 399,285 cu. yds. of rock from the canal prism, at an average cost of 23.60 cts. per cu. yd., including plant and division expenses. The total silting between miles 1 and 2, as shown by surveys during the year, amounted to 493,365 cu. yds., and the fill for the year in mile 3 amounted to 461,922 cu. yds., and the total fill during the year is estimated at 3,500,000 cu. yds., of which 550,000 cu. yds. resulted from the Chagres River flood in November, 1909.

BREAKWATER.—The location of the west breakwater for the protection of the waters of Limon Bay and the canal channel through these waters was definitely fixed on March 10, 1910, after examinations by soundings and borings covering an extended area. The plan originally presented contemplated a breakwater running out to a 44-ft. depth. Another proposition was to build on a line parallel to the first but outside of it so as to reach 48 ft. of water. The area between these two and well within the first was examined with a view to ascertaining whether better bottom might be secured. As a result of these studies and examinations it was decided to adopt the first, because a sufficient protected area beyond the 40-ft. contour will be obtained, and because of economy.

Central Division.

The work of this division embraces all the excavation between the Gatun dam and Pedro Miguel locks. The work is in charge of Lieut.-Col. D. D. Gaillard, Corps of Engineers, U. S. Army, as division engineer. Due to the resignation of Mr. L. K. Rourke, assistant division engineer, a reorganization of the division was made, effective May 1, 1910, by which the position of assistant division engineer was abolished on the date that Mr. Rourke's resignation became effective, and the position of a general superintendent of construction created.

CHAGRES DISTRICT.—The Chagres River by crossing the axis of the canal 23 times before it reaches Gatun forms a series of peninsulas. The total amount removed from the Chagres section from the beginning of operations in 1907 to the close of the last fiscal year was 9,497,673 cu. yds., leaving still to be excavated an estimated amount of 3,415,944 cu. yds. This estimated amount has been increased over the estimate of September, 1908, by 251,965 cu. yds., thus providing for excavating to elevation 39 above sea level instead of 40, made necessary on account of silting by floods, and by allowing 670,000 cu. yds. for silting, due to the fact that during the rainy season of 1909, 152,000 cu. yds. of sand and gravel were deposited by the river at Santa Cruz and Matachin.

CULEBRA CUT.—During the fiscal year 14,921,770 cu. yds. of material were excavated from the Culebra cut, leaving 34,893,531 cu. yds. to be removed in order to complete this section of the canal. The remaining amount includes an increase of 6,408,560 cu. yds. over the estimate made in September, 1908. This increase is due to widening the canal north of Pedro Miguel lock so as to form a basin, adding thereby 932,572 cu. yds., and to allowing 5,475,988 cu. yds. for slides and breaks, as a number of new ones developed during the year and

could not be foreseen when the estimate of September, 1908, was made.

Previous to the fiscal year the movement of material into the prism was due almost entirely to slides caused by the movement of the top layer of clay upon smooth sloping surfaces of rock or other material harder than the clay. In addition to the slides, however, several breaks have occurred in the banks of the canal. At the points where these breaks exist the underlying rock is of poor quality, intersected by vertical seams, or seams sloping toward the canal. Generally, the upper surface of the broken portion of the bank remained approximately horizontal, settling nearly vertically. The weight of the broken portion forces up and displaces laterally the material lying directly below it in the bottom or on the berms of the canal. As the material thus forced up is taken away, the upper part gradually settles and moves toward the axis of the canal until the entire broken portion is removed.

In widening the canal so as to secure the requisite final bottom width, the benches or berms that existed were removed, and while this method reduced to a minimum the amount of additional excavation, it exposed fresh surfaces to the action of tropical downpours and at the same time increased the pressure at the bottom. It was expected that slides would occur, and in the estimates provision was made for them, but it now appears, from cracks that show in the upper surface adjacent to the faces of the cut, that sufficient allowance had not been made, and the estimates were corrected to meet the new conditions.

Of the slides proper, the most important is the one at Cucaracha, referred to in previous reports. The total area embraced since the commencement of operations is 47.1 acres. Prior to July 1, 1909, 1,125,017 cu. yds. of material had been removed from this slide, and 639,239 cu. yds. were removed during the fiscal year.

The next largest slide is on the west bank of the canal where the village of New Culebra was located. It has been caused by the movement of a large French dump into the canal. The area involved amounts to 7.3 acres. Prior to July 1, 1909, 118,024 cu. yds. had been removed, and 327,540 cu. yds. were removed during the year.

The third slide covers an area of 4.6 acres, and is located on the east bank of the canal directly opposite Whitehouse yard. Prior to July 1, 1909, 50,800 cu. yds. of material had been removed, and 110,000 cu. yds. were removed during the present fiscal year.

The fourth slide covers an area of 1.7 acres on the east bank of the Obispo diversion at La Pita Point, where the west slope of a hill broke away and commenced to slide toward the Obispo diversion. Steps were taken to remove this material before it could cut off the diversion, and 15,608 cu. yds. were taken away.

Three bad breaks occurred during the year. On the west bank of the canal at the town of Culebra the break covers an area of 10½ acres, and during the fiscal year 1,500,388 cu. yds. were removed, making a grand total of 1,680,000 cu. yds. since the break began.

The second largest break, directly opposite that just described, covers an area of 11½ acres on the east side of the canal; during the year 314,184 cu. yds. were removed, making a total from this locality of 480,202 cu. yds.

The third break was at La Pita Point, and permitted the waters of the Obispo diversion to flow into the canal for a period of three days, drowning out some of the shovels at the north end. This break aggregates about 40,000 cu. yds., but will not be disturbed until the dry season. A flume has been constructed of timber and concrete to carry the flow of the diversion past the break.

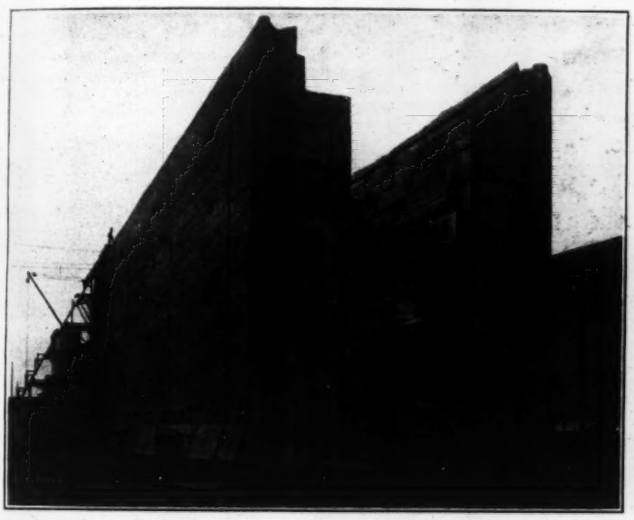
The total amount of material removed from all slides and breaks in the central division during the fiscal year amounted to 2,649,563 cu. yds., or about 15% of the amount removed from the Culebra cut.

During the year 17,749,306 cu. yds. of material were deposited in various dumps. The most important of these are at Tabernilla, the relocated Panama Railroad between Gamboa and Caimito, Miraflores, and at Balboa. In addition, over 1,150,000 cu. yds. of material removed from Culebra cut were taken to Gatun and deposited in the toes of the dam. Material deposited at Balboa is useful in that land is reclaimed from the ocean, which will in time be valuable. During the year 108 additional acres were reclaimed, making a total of 253 acres.

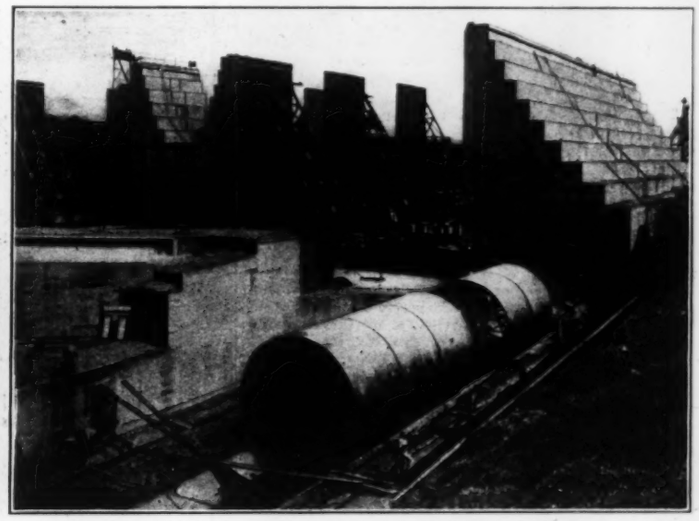
As previously reported, a breakwater was started from Balboa toward Naos Island with the object of cutting off silt-bearing currents from the excavated channel in the Pacific, thereby reducing the cost of maintenance, and making navigation of the channel easier by protecting vessels from the existing cross currents.

Prior to July 1, 1909, the trestle had been constructed for a distance of a little over 2 miles, and during the fiscal year this trestle was extended 1,123 ft., giving a total length from shore of 2.4 miles. The end of the trestle was within 4,900 ft. of Naos Island, and the filling extended to within 400 ft. of the end of the trestle. Much trouble was experienced in extending the outer end of the dike, due to the sliding of the bottom when the weight of the stone filling was dumped from the trestle. This sliding has taken place at every foot of the last 4,000 ft. of the dike, and a continual settlement of the roadbed for two or three months, after which it gradually diminishes, and finally ceases. The work so far accomplished has been of material benefit in securing the objects originally sought.

The average cost of excavation for the year was 66.99 cts. per cu. yd., including plant charges and division expenses.



MIDDLE WALL OF GATUN LOCKS, SHOWING CENTERING FOR CULVERT.



VIEW OF UPPER LOCKS AT GATUN.

Pacific Division.

The work in this division consists of the construction of the locks and dam at Pedro Miguel, the locks and dams at Miraflores, the Ancon quarry, dredging for sand at Chamé, excavating a channel between the locks and below Miraflores locks to deep water in the Pacific, such municipal work as may be required within the territorial limits of the division, and such sanitary engineering work as may be prescribed by the sanitary department within the same area. The work is in charge of Mr. S. B. Williamson, as division engineer.

PEDRO MIGUEL.—Work has continued in excavating the lock site and the approaches thereto from the south. The total amount of excavation during the year was 277,935 cu. yds. by steam shovels, and 65,513 cu. yds. by hand, of which 44,948 cu. yds. were classed as preparing foundations. Excavation proper was done at an average cost of $1.188 per cu. yd., including plant charges and division expenses. In the preparation of the foundations a total of 64,084 cu. yds. were removed, at an average cost for the last six months of $2.8193 per cu. yd., including plant charges and division expenses.

Bids were invited for the lock construction plant, Oct. 8, 1908. The largest amount of concrete in the division is to be laid at Miraflores, and while in the selection of the plant the economical handling of this material was the guiding consideration, another important factor was that the plant should be capable of being adapted to the work at Pedro Miguel. Cantilever cranes were adopted and a contract was entered into with the Wellman-Seaver-Morgan Co., of Cleveland, Ohio, on May 8, 1909, for furnishing the material and for assistance in the erection. As designed for Miraflores, one arm of the berm cranes will transport material from the storage piles to the mixers on the cranes. The product will be passed by the boom arms to the side walls or to the chamber cranes in the locks, which will place the concrete in the center walls. Both the berm and chamber cranes will handle forms and the steel or cast iron embedded in the concrete.

At Pedro Miguel the banks adjacent to the lock pit are such as to prevent the berm cranes from functioning as at Miraflores, so they are arranged with two cantilever arms, placed in the forebay of the locks, and used solely for transporting material from the stock piles to the mixers and for mixing. The chamber cranes place the mixture in both the side and center walls, as well as handle all the forms and steel or iron work. The concrete is carried from the mixers by narrow-gage construction locomotives hauling two flat cars, each carrying a 2-yd. bottom-dump bucket, which is taken by the chamber crane and the concrete deposited in the walls.

The contract required the delivery of one berm and one chamber crane by Aug. 20, and one berm and two chamber cranes by Sept. 20, 1909. Due to causes beyond the control of the contractor the deliveries were delayed, and as cement deliveries were based on the dates noted, when advised of the delays, arrangements were made to install mixers for building the lower guide or approach wall and for laying concrete in the floors in advance of the receipt of the construction plant. To this end three ½-yd. mixers were employed in the approach walls, and two 2-yd. mixers were installed temporarily, one on the east and one on the west side of the lock pit, for laying the lateral culverts and the floors.

The first berm crane was delivered on Oct. 10, and the first chamber crane on Oct. 25, 1909, but erection was interfered with by the excessive rains, so that it was not until April 4, 1910, that one-half of the regular plant was installed and began laying concrete in the west and center walls. The temporary mixer on the west side was then dismantled, but the one on the east side was continued in service until the close of the year. The entire construction plant at Pedro Miguel began operations on July 15, 1910.

The total amount of concrete laid was 16,869 cu. yds., of which 1,656 cu. yds. were large stone placed in the mass. Of this total, the permanent plant laid 73,083 cu. yds. on the basis of an eight-hour day. The average cost per cubic yard for concrete placed in the Pedro Miguel locks was $6.089, including plant charges and division expenses. The estimated amount of concrete in the locks, including approach and wing walls, is 858,600 cu. yds., so there remain 691,732 cu. yds. to complete.

Steel collapsible forms are used for the main and lateral culverts, and wooden forms in built-up panels, 15 ft. long and 8 ft. high, are used for the construction of the walls. The panels are a series of uprights, 14 ft. long, held together by waling strips and lagging. The latter is placed on the upper 6 ft., the lower 8 ft. acting as cantilevers on the concrete previously placed. The anchor bolts extend into the masonry for 2 ft., and are

removed as the work progresses, leaving the anchor nut embedded. Each panel is used at least twelve times.

MIRAFLORES.—The excavation for the upper locks of the flight at Miraflores was practically completed during the years, and the work of preparing the foundations, erecting concrete plant, and placing concrete begun. The total amount excavated was 234,731 cu. yds. by steam shovels, and 59,008 cu. yds. by hand, scrapers, and cranes; the actual excavation work being done at a cost for the last six months of $1.369 per cu. yd.

A 20-in. suction dredge worked in the lower lock site until Dec. 20, 1909. Because of the large number of boulders encountered, and the character of the material, the output was small and the performance of the dredge unsatisfactory. As this dredge could be utilized to advantage in the Atlantic division, it was transferred, and arrangements are being made for excavating the remainder of the material by hydraulic means. The dredge removed 141,759 cu. yds., at an average cost of 50.63 cts. per cu. yd.

The work of preparing the foundation of the upper locks was begun as soon as the excavation was completed sufficiently, and consisted of cleaning up loose material and excavating for the lateral culverts and the areas above the miter sills. This work was done by a Thew steam shovel and by hand, the total amount excavated being 39,381 cu. yds. Excavation by steam shovels, classed as preparing foundations, was 24,655 cu. yds. The average cost was $1.947 per cu. yd.

The handling plant in these locks will consist of four berm cranes, two of which are in operation in the forebay at Pedro Miguel, and four chamber cranes, all of which are in use at Pedro Miguel. The tower and movable boom of one of the berm cranes is in place completely erected, and another on the west side partially erected. The cantilever arms will be placed on these cranes when the berm cranes at Pedro Miguel are dismantled and transferred.

On June 1 concreting in the upper lock was begun on the floor and lateral culverts, the mixture being furnished by two ½-yd. mixers, as it is desired to complete the floors before the permanent plant is transferred from Pedro Miguel. The total amount of concrete laid was 1,630 cu. yds., at a cost of $7.393 per cu. yd. The estimated amount of concrete in the locks, including approach and wing walls, is 1,327,300 cu. yds.

A reinforced-concrete power-house at Miraflores has been finished, at a total cost, including equipment, of $486,096, and is now in operation. One end of the building and a portion of the turbine-room floor are of temporary construction, as the depth and width of the water turbines to be used have not yet been determined. It furnishes power for the operation of all the cranes, for the crusher plant at Ancon, and for the sand-unloading cranes at Balboa.

HYDRAULIC MACHINERY.—The material to be removed in the 2-mile stretch of channel below Miraflores locks amounts to about 9,650,000 cu. yds., of which over 1,500,000 cu. yds. are rock. As time is one of the important elements and it was impossible to assemble a sufficiently large dredging plant to complete this section within the limit fixed, an hydraulic excavating plant was selected as being not only the most expeditious method of handling loam overlying the rock, but the cheapest. It has an additional advantage in that the material removed can be utilized in reclaiming swamp lands adjacent to the line of the canal and belonging to the commission.

The plant as designed contemplates the washing of the material overlying the rock to sumps by means of a water jet under high pressure, and of dredging pumps elevating and conveying the material from the sumps through flumes. It consists of a central pumping station, pipe lines, hydraulic monitors, and dredging pumps. The central station is located on the west bank of the canal, and in the center of the area to be excavated. There are mounted four Worthington horizontal, direct acting, triple expansion pumping engines with 24-in. stroke, 24½-in. water cylinders, and 19, 30 and 50-in. steam cylinders. The supply pipe from the pumping station is 3,600 ft. long, made up of 2,000 ft. of 40-in. and 800 ft. of 32-in. lock-bar pipe, and 800 ft. of 24-in. spiral riveted pipe. The main is provided with valves and tees suitably located for connecting branch lines leading to the monitors. The branch lines are 16-in. spiral riveted pipe laid in groups of three so that two giants may be continued at work while the third is being changed. The monitors are fitted with special deflecting nozzles. The dredging pumps, three in number, are 18-in. single suction centrifugal pumps, direct connected to a 655-HP. induction motor. These pumps, with motors, switchboard, and priming pump, are all mounted on reinforced-concrete barges specially designed by the division engineer and constructed for the purpose.

The Rio Grande River which originally occupied a portion of the area to be excavated has been diverted and a dike constructed across the south end to prevent the access of tidewater to the area. After the removal of loam overlying the rock by hydraulic process, the rock will be excavated by means of steam shovel in the dry, that method being the most economical.

South of the area to be excavated by hydraulic means, the necessary depth and width of channel will be secured by ordinary dredging operations. During the year, there were employed at this work the 20-in. seagoing suction dredge "Culebra," one 5-yd. dipper dredge "Cardenas," and four French ladder dredges. The total output of these dredges aggregated 6,914,384 cu. yds., of which 57,161 cu. yds. were classified as plant, at an average cost of $0.2408 per cu. yd., including plant charges and division expenses. Bids were invited for the delivery of a ladder dredge having a capacity of 1,200 cu. yds. per hour in sand and mud, for use in the division and subsequently for maintenance work through the canal.

Three methods are employed in breaking up the rock in this section so that it may be handled by the dredges; the rock lies in separate shoals of comparatively small area and volume. The first method is by drilling and mining, in which case well drills operate through the overlying earth to a depth below the required grade; the holes are sprung, charged, and fired. By this means 274,339 cu. yds. of rock were broken up, of which 19,392 cu. yds. were removed by the dredges.

The second method is by subaqueous blasting, for which purpose a drill barge was constructed consisting of a steel hull 112 ft. long by 36 ft. 8 ins. wide, provided with timber spuds—one at each corner of the barge. Three drill frames 38 ft. high are located along one of the gunnels, arranged to move lengthwise of the barge on rails. Each frame carries a slide to which is attached a 5½-in. rock drill, and each slide is operated by a hydraulic ram and may be moved vertically through 10 ft. The drills are operated over a distance of 85 ft. from one position of the barge, and the holes thus far have been spaced 5 ft. apart on 6-ft. centers located by means of ranges on shore. The barge began operations in March, 1910, and blasted over an area of 49,600 sq. ft. No dredging was done.

The third method is by rock breaking, and a Lobnitz rock breaker was placed in commission in August, 1909. It consists of a ram or cutter of steel fitted with a hardened steel conical point which is alternately hoisted and dropped. The device is mounted on a steel hull 100 × 28 × 8 ft. The tidal range requires the use of three sizes of rams, 30, 40 and 56 ft., weighing approximately 15, 16 and 19½ tons. The general practice has been to attack with the rock breaker the surface of a rock shoal which has been exposed by dredging at intervals of 4 ft. each way, the points of attack being located by ranges on shore and permanent marks on the bay. The average limit of penetration thus far has been 3.12 ft. After the entire area of a shoal is gone over, the rock breaker is removed and the broken rock dredged out. The area covered during the year was 266,230 sq. ft., from which 25,515 cu. yds. were dredged.

The Construction of the New Panama Railroad.

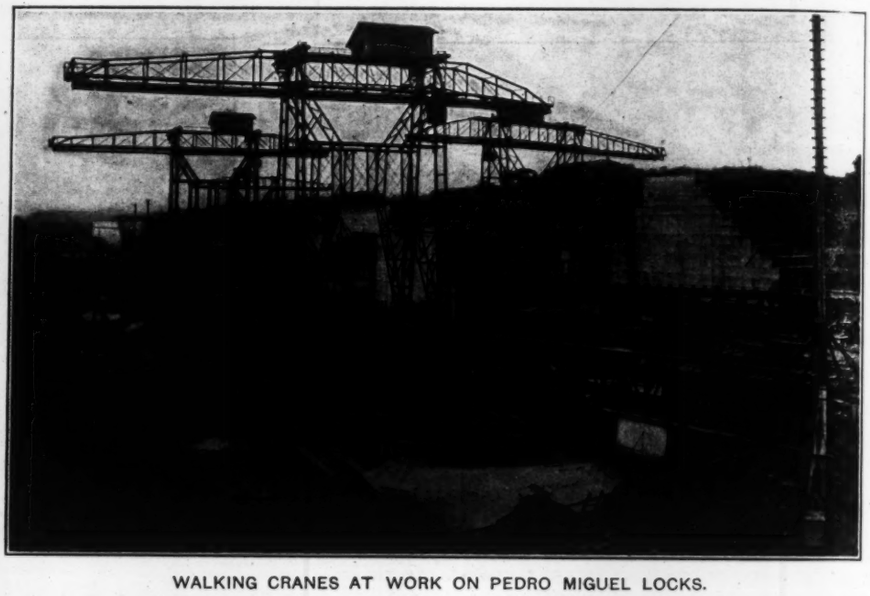
The construction of a new line for the operation of the Panama Railroad is being done by the Panama R. R. Co. under an agreement with the commission. It was in charge of Mr. R. Budd, chief engineer of the Panama Railroad, until he resigned Sept. 21, 1909, since which date Lieut. Frederick Mears, First Cavalry, U. S. A., was promoted to fill the vacancy created, and has continued in entire charge.

At the beginning of the year work was in progress upon the entire stretch from Gatun to Gamboa, with the exception of eight miles through the valley of the Gatun River. As canal construction contemplated the closing of the west diversion and discharging the Chagres River through the spillway, the elevation of the floor of which was placed 10 ft. above sea level, work on the relocation had to be arranged so as to give continuous communication at such times as the main line of the Panama Railroad is flooded. Work was therefore pushed in order to have a through route ready and available for use in case of necessity, and a temporary line on the 87 ft. level was completed on April 23. In accomplishing this trestles were driven over the bottoms of the Quebrada, the Brazos, the Baja, and the Gatun, and while of necessity they were outside the center line, they are arranged that when filled these fills will form parts of the completed embankments. The filling in of all these trestles is under way, and no special difficulty has been met thus far except across the Baja bottom, where the material overlying the rock is very soft and treacherous.

Mechanical Division.

The second division of the chief engineer's office has charge of all mechanical questions that may arise and supervises expenditures, the preparation of estimates, allotments for work, and cost keeping. It is under Mr. H. H. Rousseau, U. S. Navy.

To reduce delays on account of breakdown of machinery, plant, and equipment, which reflect largely in the unit cost of work, to a minimum, and to provide proper facilities for overhauling plant and equipment, as well as manufacturing necessary repair parts, large shops have been provided at certain points on the Isthmus,



WALKING CRANES AT WORK ON PEDRO MIGUEL LOCKS.

in which are employed 1,399 "gold" men and 2,992 "silver" men, or a total of 4,391. Other small shops employing one-half dozen or less men are distributed around the work where required. Cars converted into portable machine shops are also used, and in a similar way floating machine shops are provided for repairing marine equipment.

In general, the repair shops and equipment on the Isthmus are adequate to meet all requirements during the construction period. Nothing as yet has been done toward permanent shop facilities needed after completion of the canal, but in respect to this feature the commission at its one hundred and fifty-sixth meeting declared itself in favor of a policy which will, if adhered to, result in confining such permanent shop facilities to two points, one near each end of the canal, equipped to meet all requirements of the United States in connection with the maintenance, operation, and protection of the canal, as well as the needs of the Panama Railroad, and those arising from the commercial use of the canal.

During the year 4,820,762 lbs. of iron castings were made, at a cost of $0.02937 per lb., and 393,995 lbs. of brass castings, at a cost of $0.1723 per lb., both exclusive of surcharge, but inclusive of the cost of patterns and material.

This division has continued the operation of all electric-power plants, except those at Gatun and Miraflores, furnishing current for about 31,000 lights.

The operation of the air compressors is also under this division, and 7,227,203,513 cu. ft. of compressed air were generated during the year. Additional compressors were installed at Empire and Rio Grande plants, and 8,810 ft. of main pipe line were removed and rebuilt on account of slides occurring through Culebra cut, and 3,600 ft. of 8-in. main installed between the Balboa plant and the Ancon crushing plant of the Pacific division.

Appropriations.

The appropriations made by Congress for the Isthmian Canal and available to the close of the fiscal year 1909, amounted to $210,146,468, or 56% of the total estimated cost of the canal, which is fixed at $375,201,000. On June 25, 1910, $37,855,000 were appropriated for the fiscal year 1910-11, leaving $127,199,531 of the estimated total cost of the canal to be appropriated. The total classified expenditures for canal work to June 30, 1910, amounted to $191,258,113, of which $31,188,426 were the net expenditures during the fiscal year covered by this report. Of the total classified expenditures to June 30, 1910, $25,690,450 were for plant and equipment for construction work, of which $4,388,511 were expended during the fiscal year.

COST-KEEPING.—Effective July 1, 1909, the subaccounts of the department of construction and engineering were contained in A, construction work, and B, plant and plant arbitraries were established as the basis for construction work. Thus, by taking up monthly the proper proportion of charges for plant and equipment expenditures, the plant charges will have been completely absorbed by the work on its completion.

The division cost of an item of construction work is made up of the cost of all labor and material directly applied to the work, a plant arbitrary and a proper portion of the general administration expenses, including expenses of the chief engineer's office and other general engineering expenses. To the division cost must be added, first, a proportion of the general expenses of the commission, including expenses of the quartermaster's and subsistence departments, examiner of accounts and disbursing office, and, second, a proper share of the expenses in the United States, and all other miscellaneous charges in order to arrive at the total cost.

River Hydraulics, Meteorology and Surveys.

The third division of the office of the chief engineer is charged with hydrographic and meteorological work, such general surveys as are embraced within the limits of any of the construction divisions, and such investigations as may be assigned to it. The division has been in charge of Mr. C. M. Saville, assistant engineer.

Gaging stations have been maintained at Gatun, Bohio and Alhajuela, on the Chagres River, at Monte Lirio on the Gatun River, and Lagartera on the Trinidad River. River stations are maintained at Vigia and Gamboa for the purpose of predicting floods.

The minimum flow during the year at Bohio was in March, 1910, when the discharge was 1,220 cu. ft. per second; the maximum was in December when it reached 90,000 cu. ft. per second.

The temperature for the calendar year 1909 was below the normal, the average being 78° F. at Cristobal and Culebra, and 79° at Ancon. The minimum temperature was 61° F. at Culebra on March 1, 1910, and the maximum at Culebra, April 15, 1909, 94° F.

The rainfall for the calendar year was greater at all stations; the maximum noted was at Porto Bello, where 237.28 ins. were recorded for the year. The maximum monthly rainfall also occurred at Porto Bello in December, 1909, registering 58.17 ins. Hail fell at Alhajuela on the afternoon of May 28, 1910. On the whole, there was a deficiency of wind movement during the year, though during a storm at Ancon on July 10, 1909, the wind attained a maximum velocity for one minute of 70 miles an hour, and for five minutes of 59 miles an hour, the greatest velocity of record on the Isthmus.

Slight seismic disturbances were of frequent occurrence during the year, very few of which, however, were physically observed in the Zone. Except in cases of minor local tremors, the records at Ancon harmonize with records in the United States, Mexico and Europe.

Careful record of evaporations at various points along the line and the time of duration of fogs has also been kept.

The survey of the watershed of the Chagres was completed.

The investigations which were started the previous year of the low divides at the headwaters of the Trinidad for the purpose of determining what steps, if any, should be taken to prevent overflow of the lake were continued. At one of the Cano saddles the distance through the range at elevation 85 is 50 ft., and at no place between the 90-ft. contours is it more than 100 ft. Investigation of this locality indicates that it will probably be necessary to increase the height, which can readily be done with material easily accessible. East of Gatun another saddle will probably require some reinforcement.

Quartermaster's Department.

The quartermaster's department is charged with the recruitment of labor; care, furnishing, and assignment of quarters; distributing fuel, commissary supplies, and distilled water; construction and repair of all buildings; requisitioning for supplies of all kinds, together with the receipt and distribution of them on arrival; cutting of grass and disposal of night soil and garbage as prescribed by the sanitary department, and the auditing of all property returns. The department is in charge of Lieut.-Col. C. A. Devol, chief quartermaster.

The average number of gold employees on the rolls of the commission during the past year was 4,369, and of the Panama Railroad 753, or a total of 5,122. During the year there were 2,890 separations from the service of the commission, and there were employed in the United States, 1,099, on the Isthmus 1,092, and re-employments on the Isthmus 967, or a total of 3,158, indicating that more than 60% of the force was changed during the year, showing the usual unstable conditions of the gold force.

Laborers recruited during the year aggregated 2,519; all were West Indians, the larger part of them from Barbados. The last recruiting was done in January, 1910, since which date immigration has exceeded emigration, and, as the work has reached its maximum, the present population of the Zone furnishes an ample labor supply. There has always been an independent immigration from the West Indian islands, but it was not until within the last four months that there has been any such movement on the part of European laborers. During this period, however, 2,000 have come of their own volition from Spain and Italy. From the beginning of the fiscal year there was a steady increase in the force, until a maximum—38,676—was reached on March 30, 1910, including the Panama Railroad Company and the relocation, and is the largest force on record. Since that time there has been a slight decrease, but the total effective force on June 30 was 35,578, as compared with 33,493 on June 30, 1909.

The total amount of material received from the United States during the year aggregated 350,000 tons, valued at $10,103,552.34. The value of local purchases, including coal and oil, was $2,094,131.02; 345,185 tons of coal and 465,921 barrels of fuel oil were used. The stock in storehouses at the end of the fiscal year amounted to $4,691,034.10.

Department of Sanitation.

The work of this department embraces sanitary work in the cities of Colon and Panama and, except oiling, it designates the sanitary work to be done in the Canal Zone in order to accomplish the desired ends, exercising such supervision as is necessary to see that the work is satisfactorily performed; in addition, the department has charge of hospitals and quarantine. The department is in charge of Col. W. C. Gorgas, Medical Corps, U. S. Army, as chief sanitary officer.

The work in the terminal cities consists of cutting grass and brush, oiling pools, and constructing and maintaining ditches for drainage purposes, removal of garbage and night soil, fumigation and street cleaning.

In the Canal Zone, the quartermaster's department expended under the direction of the sanitary department $127,923.28 in grass and brush cutting in and about commission settlements, and $47,009.87 for the removal of night soil and garbage. The amount expended for the removal of garbage and night soil in native settlements was $25,414.51. In the maintenance of existing ditches and the construction of new ones for drainage purposes the construction division expended a total of $88,545.83; the new work was done in accordance with plans prepared by the sanitary department. The total amount expended for oil, and labor in its distribution, was $42,686.58.

The health conditions on the Isthmus are reported by the chief sanitary officer as an improvement over those of the preceding year. The total admissions to hospitals and sick camps, including those sick in quarters, netted for the year 26,539. The daily average of sick was 23.01 out of every thousand employed, as against 23.49 for the preceding year. The total number of deaths among employees was 548, equivalent to an average of 10.84 per thousand.

In addition to the number of deaths reported among the Americans, which aggregated 76, 39 were deported on the recommendation of the medical examining boards as physically unfitted for the Tropics, 10 were recommended for extended leave without pay for the same reasons, and 6 were given extended leave with pay in the United States on account of injuries received in line of duty.

No cases of plague or yellow fever originated on the Isthmus.

Washington Office.

The work of the Washington office was of the same scope as reported for the preceding year, and continued in charge of Capt. F. C. Boggs, Corps of Engineers, U. S. A.

The total amount of purchase orders placed during the year was $16,107,350; the most important of the purchases were castings, structural material and valves for use in the locks, amounting to $847,000; 4 steel barges; 2 tugboats; 3 launches; one 20-in. pipe line suction dredge; 1 hydraulic and dredging plant; 13 dredging, discharge, and relay pumps; 449 dump and flat cars; 10 cantilever cranes; 2 rock crushers; 8,745 tons of steel rails; 655,842 cross-ties; 32,715 piles; 30,771,744 ft. of lumber; 14,742,400 lbs. of dynamite and blasting powder.

Shipments of cement for use in the locks and dams, purchased under contract for 4,500,000 bbls., amounted to 904,727 bbls. up to June 30.

Geo. W. Goethals,
Colonel, Corps of Engineers, U. S. Army,
Chairman and Chief Engineer.

Culebra, Canal Zone, Sept. 1, 1910.

Problems in Design and Operation of Very Large Electrical Generating Systems.*

By C. P. STEINMETZ,† M. Am. Inst. E. E.

Very large systems of a few years ago can now hardly be classed as of medium size. A 1,000-light generator, that is, of approximately 100 HP. capacity, was a monster machine only a few years ago. Now we are designing 20,000-HP. units. The size of generators gradually grew larger and larger but, as the cities took up this new power, the growth was so rapid that many systems were obliged to tie in with others, making the regulation of the voltage on the lights very poor. Then the multiple-voltage and three-wire systems came into use.

The three-wire system aided wonderfully in giving better regulation, but it was due to the modern alternating-current systems that electric lighting became so successful. This was not without a bitter fight, however, between the direct and alternating-current advocates, which lasted for many years.

The alternating-current systems have a sad early history, due largely to the fact that there were then no alternating-current motors, and therefore practically no load on the system during the day. This was costly. The frequencies used at that time were too high, being 125 and 133 cycles per second. It was realized, however, that there were vast possibilities in the alternating-current system. At this period, the rotary converter, which changes direct into alternating current, or vice versa, made its appearance. A combination of the alternating and direct-current systems was first tried out on a large scale by the New York Edison Co., and then by the Chicago system with a double-current generator. The direct current was used near the station and distributed from three-wire mains, while the outlying districts were supplied with three-phase, 25-cycle current at 6,600 and 13,200 volts. This alternating current was transformed at the generators to 6,600 or 13,200 volts and then re-transformed in the suburbs to low voltages, and connected to rotary converters, giving three-wire direct current, as near the station.

As these stations developed in size the question naturally arose as to the limiting size of an economical station. Calculations were made showing that this limit was from 10,000 to 20,000 KW. These calculations were, however, based on one character of load. If a station has a greatly varied load, such as for lighting, stationary power and railways, there is practically no limit to the economical size which can be built. Mr. Samuel Insull, of Chicago, particularly brought out this argument and was willing to try it in the Fisk St. Station in Chicago, one of the largest in America. This station now has connected up to 180,000 KW., equal to almost 250,000 HP.

On such large systems, problems arise which are very difficult of solution and which were not even heard of in the smaller stations where the voltages were low, capacities limited, and the network and bus bars were of comparatively high resistance. There are high-frequency disturbances on the lines all the time, and enormous capacities behind any break-down. In fact, with a modern turbine station not equipped with special reactance coils for limiting the current, if a short circuit should occur at the bus bars, and the normal rating of the station were 250,000 HP., there might be concentrated for a moment at the point of short circuit over 12,000,000 HP.

Apparatus such as switches, circuit breakers, etc., can hardly be made to take care of such enormous powers and it has been found necessary to install reactance coils in each generator circuit and also in the bus bars between groups of generators. These reactances, in order not to saturate, or "lay down," and cease to limit the flow of current on such enormous loads, are constructed with non-magnetic cores. They are also subject to enormous mechanical strains, up to hundreds of tons, when the short-circuit current is thrown upon them, so that their design is very difficult.

A comparison of these disturbances to waves of water, facilitates an understanding of this subject by the non-technical man. With a small body of water, it takes a hurricane to raise a wave of appreciable size; while on the ocean, even on calm days, there are always wave disturbances. The electric waves caused by switching, etc., may be of limited power, but when they meet an obstruction, just as is true with water waves, they may rise to unlimited heights, or voltages, depending on the nature of the obstruction. It is for this reason that the end turns of high voltage transformers are more heavily insulated than the other turns.

Owing to the damage resulting from enormous short-circuit currents, it is now becoming customary to specify regulation by giving a limit to the short-circuit current in terms of full-load current, usually 15 times normal. Other difficult problems have arisen with the advent of very large systems, and much time and effort is being spent on them, both by manufacturers and operators.

*Abstract of lecture at a meeting of the Pittsfield (Mass.) Section of the American Institute of Electrical Engineers, Oct. 13, 1910.

†Consulting Engineer, General Electric Co., Schenectady, N. Y.

Construction of the Kinzie St. Drawbridge (Chicago) and Its Deep Foundations: Chicago & Northwestern Ry.

By W. H. FINLEY,* M. Am. Soc. C. E.

When improvements in the north branch of the Chicago River (in aid of navigation) made it necessary to rebuild the double track bridge carrying the Chicago & Northwestern Ry. tracks over the river just south of Kinzie St., the problem presented to the railway company's engineers was how to accomplish this work with the least interference to railway traffic. The bridge is only a few hundred feet west of the Wells St. passenger terminal station, and just beyond its west end is the junction of the Galena and Milwaukee divisions, both double-track main lines. The main line and suburban traffic is very heavy, averaging about 373 trains per day over the bridge, in addition to switching and light engine movements. The bridge forms a double-track throat through which must pass every train entering and leaving the terminal. The congestion at this point is so great that the track connections and interlocking are arranged to permit of both bridge tracks being used in the same direction. Thus at the rush hours of the morning and evening, two trains (one for each division) can approach or leave the station simultaneously.

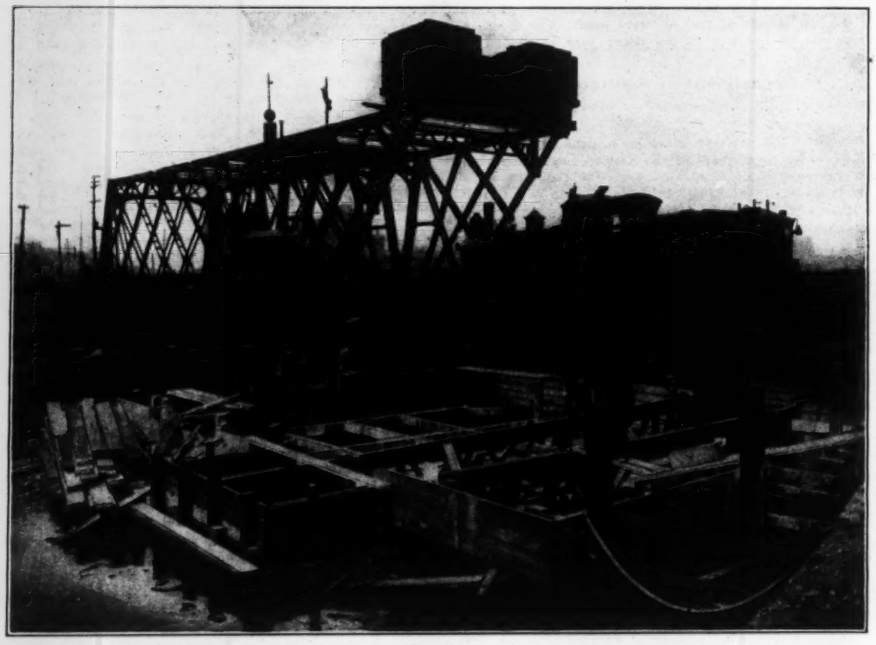


FIG. 1. OLD KINZIE ST. SWING BRIDGE CONVERTED INTO A "BOBTAIL" SPAN TO AVOID INTERFERENCE WITH WORK ON FOUNDATION AND PIER OF ADJACENT NEW BASCULE BRIDGE: CHICAGO & NORTHWESTERN RY.

The old bridge (built in 1898) was a double-track, through-truss riveted-lattice swing span, 195 ft. long, with the center of rotation located under the center line of the south truss. The navigable channel was west of the center pier and the west end of the bridge swung to the north when opening for vessels, giving a clear channel of 95 ft.

The arrangement of the tracks in the terminal yard just east of the river fixed the location of the new bridge south of the old bridge. It was very evident that a bascule type of structure that could be erected in a vertical position would give the least interference to the railway traffic and river navigation. One remaining problem to be considered was on which side of the river the trunnion pier should be located. If placed on the west side the opening of the old bridge would not interfere with the construction of the pier or the erection of the new span. But the work would have to be carried on in the navigable channel and subject to the interference and risk of damage by passing vessels. This location would also bring the pier foundation close to a large warehouse on pile foundations. On the other hand, if located on the east side it would interfere with the east arm of the old bridge (swinging south). After due consideration it was decided to locate the trunnion pier on the east side, and to cut off a sufficient part of the east arm of the old bridge to clear the new work. This permitted the new bridge to be constructed in the open position with its center line 39 ft. 9 ins. south of (and parallel to) the center line of the old bridge.

After a careful comparison of the different types of bascule bridges it was decided to adopt the Strauss type. The new bridge consists of a through riveted-truss span, 170 ft. long from center of trunnion to center of bearing on the rest pier. A 27-ft. plate girder deck span forms the west approach and extends from the rest pier to the west abutment. Further particulars of the superstructure are given later.

As mentioned above, one of the first steps necessary was to cut off the east arm of the old swing bridge. In preparing for the work piles for a double-track trestle were driven under the east arm of the old swing span, and timber placed as far as could be done without interfering with the movement of this bridge. On Sept. 1, 1907, the east arm was cut off, only enough being left to support counterweight boxes loaded with 165 tons of pig iron to balance the west arm. For this work, the bridge was swung open, and blocked up on the timber protection pier. The entire work of cutting off the arm, placing the counterweights and completing the trestle approach to the shortened swing span was done by company forces and was accomplished in eight hours. The traffic in the meantime was handled from the west side of the river. Fig. 1 shows the old span thus altered, and work in progress on the pier for the new bridge.

This old bridge was afterwards reassembled, lengthened three panels, and re-erected to carry the Madison Division over the Kinnickinnic River at Milwaukee, Wis.

With the "bobtail" swing bridge in operation, the work on the two abutments was proceeded with. The rest pier was left to the last as it would have obstructed the channel, the width of which was reduced to 56 ft. during the work on the bridge. The superstructure was erected in the vertical open position upon the east abutment.

Traffic was diverted to the new structure partially on Sept. 18, 1908, and completely on Sept. 20, the old bridge being then abandoned. With the old bridge in the closed position, the west arm was cut off and floated out on two scows 28x50 ft. The bobtail arm and center pier were then taken down, and the old center pier removed as rapidly as possible. The dredging, pier protection, etc., remained to be done, but the work was completed by Jan. 20, 1909.

Trunnion Pier and Foundations.

On account of the possibility of tunnels for subways or other purposes being constructed at some future time in the vicinity of the bridge, it was decided to carry the foundation of the north or trunnion pier (on the east side) to bed rock. An artesian well sunk some years ago within 100 ft. of the bridge located bed rock at about 110 to 112 ft. below Chicago city datum. After a study of the materials as revealed by the test borings, the writer proposed to carry a pneumatic caisson down to about elevation — 50, and from that point continue six 10-ft. wells to bed rock. The idea was that the stiff blue clay at elevation —50 would effectually seal the caisson and prevent the inflow of water from the river. This plan was approved by the Chief Engineer, Mr. E. C. Carter, M. Am. Soc. C. E.

Fig. 2 gives the dimensions and details of the timber caisson, and shows also the location and size of the wells. This caisson was constructed by the Great Lakes Dredge & Dock Co. at its yard about a mile up the river from the bridge site. It was launched Nov. 23, 1907. The caisson, drawing 12.3 ft. of water, was towed down the river and floated to place on Dec. 26, 1907. The river bed at the site had been previously dredged to a uniform depth of about 21 ft. and guide piles driven to hold the caisson to proper position. In order to place the caisson in exact position, 15 ft. of the south end of the old masonry abutment on spruce piles and timber grillage had to be removed. Great difficulty was experienced in trying to remove these piles by pulling. They could not be pulled by a pile driver on a scow 30 × 50 ft., rigged with a four-sheave block and ⅞-in. wire cable. The 1-in. chain around the piles cut some of them off at about the water line. Finally the expedient of breaking them off with dynamite was adopted. This was accomplished by driving a 2-in. pipe down alongside of a pile, placing a 5-lb. charge of dynamite in the bottom of this and exploding it. The north cutting edge of the caisson in landing rested on the tops of three of these broken piles which were cut off as the sinking of the caisson progressed.

The placing of concrete inside the crib was begun on Dec. 27, 1907, and continued until Jan. 6, 1908, when the air was turned on and the sludge forced out through the blow pipes. The cutting edge at this time rested at elevation — 20.8 ft. Only the silty material accumulated after the dredging was handled in this manner. Excavation by the use of buckets and diggers started on Jan. 10, and was carried on continuously until Feb. 21, 1908, when the caisson was landed in its final position with the cutting edge at elevation —50.8 ft. The material passed through was a plastic clay, becoming harder as the depth increased until at the elevation where the caisson was stopped it was a fairly hard blue clay but could be excavated without picking.

When the caisson was finally landed and ready for air to be turned on it weighed 2,325 tons, made up of 495 tons of timber and iron and 1,830 tons of concrete over the roof in the crib. It had a total displacement of 48,000 cu. ft. In sinking, concrete was continually being added in such quantities that the caisson was lowered during the earlier part of the work with no reduction of air, the additional weight placed being sufficient to overcome the skin friction as excavation was made at the cutting edge. During the latter part of the sinking, as the skin friction increased, a reduction of air pressure of from 2 to 4 lbs. was required, and a drop of from 2 to 4 ft. was obtained.

When the caisson was landed in its final position the total weight was 5,162 tons, made up of 592 tons of timber and iron and 4,570 tons of

*Assistant Chief Engineer, Chicago & Northwestern Ry., Chicago.

concrete. The total displacement was 121,500 cu. ft. Just previous to final lowering the skin friction was estimated to be 900 lbs. per sq. ft. of surface.

The caisson was of the usual timber construction, 48 × 53 ft. in plan, with a working chamber 8 ft. high. It had six steel shafts 4 ft. diameter, one over each of the wells to be sunk. One of these shafts was capped with a Moran lock through which all the excavated material was removed. This material was dumped over the edge of the caisson into the river, to be dredged away later. Another shaft was capped with a man lock, the chamber being of such size (8 ft. diameter) as to accommodate the entire working force. A third shaft was fitted with an air lock for passing down bracing and lagging for the wells, and also for use by foremen and others going in and coming out frequently. The other three shafts were used to some extent while filling the wells and the working chamber.

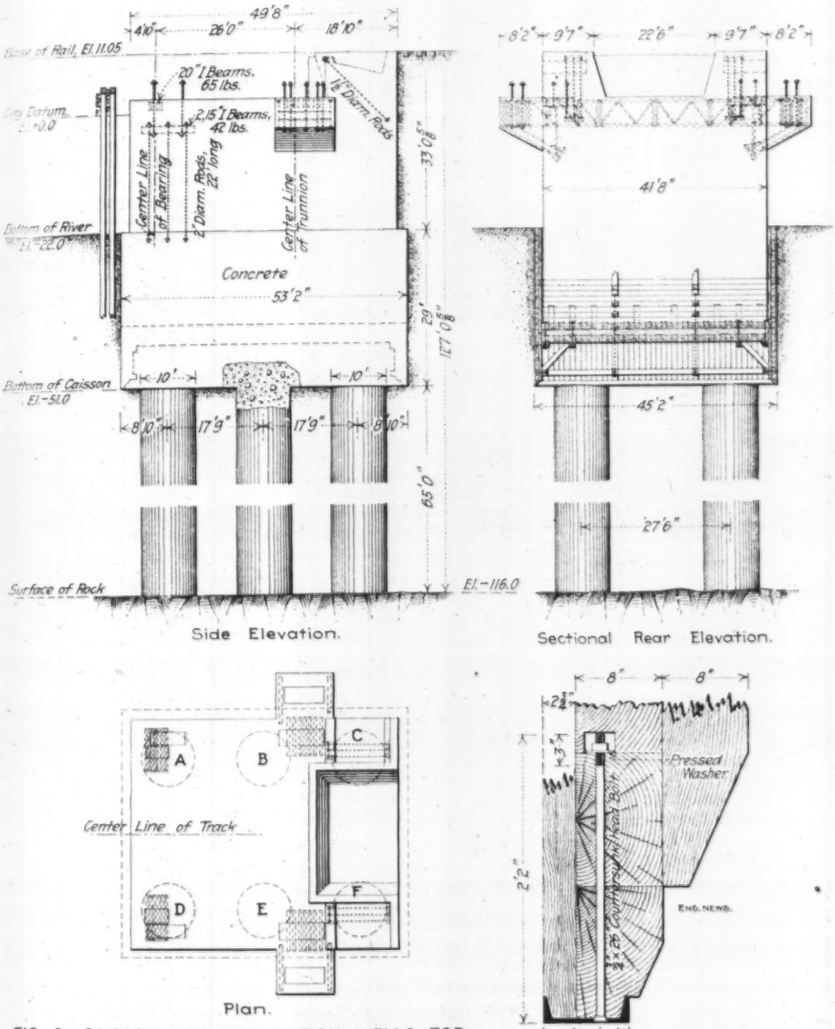


FIG. 2. CAISSON AND FOUNDATION WELLS FOR MAIN PIER OF NEW BASCULE BRIDGE OVER THE CHICAGO RIVER; CHICAGO & NORTHWESTERN RY.

The concrete was a 1:3:5 mixture, except for the top 3 ft. of the work, where it was 1:2:4. The inside sheathing of the cofferdam above the caisson served as the form up to 4 ft. below datum, at which level neat lines were established. The quantities of material at this pier were as follows:

	Concrete, cu. yds.	Timber, ft. B. M.
Wells	1,210	....
Caisson	761	155,804
Crib	622	29,179
Cofferdam	2,773	88,649
Total	5,366	273,632

Three air compressors were in operation while the maximum amount of air was being used: (1) an Ingersoll-Sergeant duplex (16 × 16¼ × 18 ins.) direct-connected, delivering 598 cu. ft. of free air per min.; (2) a Knowles duplex (14 × 14 × 16 ins.), 480 cu. ft.; and (3) a Rand single machine (8 × 12 ins.), delivering 250 cu. ft. All were operated by steam supplied by two marine boilers of 60 HP.

As a rule, two or three wells were in progress at one time, and as soon as a well was down to bed rock it was concreted. This filling was done as far as possible by the day shift, the night shifts doing the excavation. This arrangement permitted using the same lagging and rings over again to a considerable extent, and kept one concrete mixing crew busy throughout the day. The concrete was mixed by machine, and dumped into the buckets for lowering through the material lock into the working chamber. There it was rehandled, being shoveled to the various wells. For delivering the concrete into the well a 10-in. sheet iron pipe was used; this was made with telescopic sections which were removed as the work progressed.

The uniformity of the tough impervious clay through which the caisson was sunk practically eliminated the possibility of blowouts, and none occurred. Nor was it necessary at any time to keep the air pressure up to the theoretical limit; only 14-lbs. pressure was used at the final depth of —51, though the theoretical requirement was 22 lbs. During the sinking of the wells the pressure was increased but slightly.

Immediately on the landing of the caisson at its final position the cutting edge was sealed with concrete, and work on the six wells was commenced. From 55 ft. below datum, the material in the wells developed into a hard-pan which required the use of a mattock for excavation. Four men in a 10-ft. well would excavate 4 to 5 ft. in 24 hours and place a set of 5-ft. lagging. The lagging consisted of vertical 3-in. tongued and grooved maple plank with inside steel ring braces. This hard material continued to elevation —104, where black sand and boulders were encountered; these continued for the remainder of the depth to bed rock, at —115 to —117. At this elevation some water appeared in the bottom of the wells, but on raising the air pressure to 18 lbs. the water disappeared. No water was encountered at any time during the sinking of the caisson or wells. In fact, water was pumped into the working chamber to facilitate the excavation of the clay.

When the first well reached an elevation of about —90, a considerable leakage of air was discovered, and upon investigation this was found to be coming up in the casing of the artesian well above mentioned, in the railway company's power house. This is a 10-in. drilled well 180 ft. deep, cased to rock at an elevation of about —90. On the removal of the cap from the top of this casing, the current of escaping air was very strong, and the movements of the compressor could be heard distinctly. This undoubtedly accounted for the leakage from the caisson, as no other evidence of leakage could be found elsewhere.

The excavation in the wells was carried out by means of buckets and hand winches, the material being rehandled in the working chamber. Here it was loaded into the main hoist buckets and raised through the Moran material lock.

On the completion of the wells, they were filled with concrete, the lagging being removed as the filling progressed. Afterwards, the working chamber was nearly filled with concrete. The air pressure was maintained until the filling was nearly completed, and was then removed entirely. No settlement of the caisson followed this. The completion of the filling was then done through the six 4-ft. shafts.

Excavation for the first well was started Feb. 20, 1908, and bed rock was reached in this well on March 9. The concreting was commenced immediately, and all the wells were completely filled by April 3. On this date the filling of the working chamber was commenced. The air pressure was released on April 5, and the working shafts were completely filled on April 6. The concreting within the cofferdam was continued and the entire abutment completed about May 1.

A progress chart of the sinking of the caisson and wells is given in Fig. 3. It shows the material encountered, the pressure and the rate of sinking. The maximum depth was 117 ft. below datum, in well C. This is believed to be the greatest depth to which bridge foundations have been sunk by air pressure.

Substructure.

The substructure work includes (1) the east abutment (which carries the trunnion bearings), (2) the rest pier to support the free end of the bascule span, and (3) the west abutment for the 27-ft. plate girder approach span. All the masonry is of concrete composed of Portland cement, sand and broken stone. The Great Lakes Dredge & Dock Co., of Chicago, had the contract for all substructure and foundation work.

The east abutment or pier whose construction has been described above, is 51 ft. 2 ins. × 45 ft. 2 ins., the greater length being parallel with the track. The caisson not being wide enough to support the main lateral bracing for the towers of the superstructure, concrete brackets were built on each side. These projected 8 ft. 2 ins. from the pier, from a point 7 ft. below datum. They are reinforced by the cantilever ends of steel trusses which extend across the pier and brackets, and which are embedded in the concrete (Figs. 1 and 2). Beds formed of groups of I-beams were provided under all main bearings, with anchor bolts extending into the concrete to a depth of 22 ft.

The rest pier is 12 × 41½ ft., and contains 220 cu. yds. of concrete. The foundation piles, driven

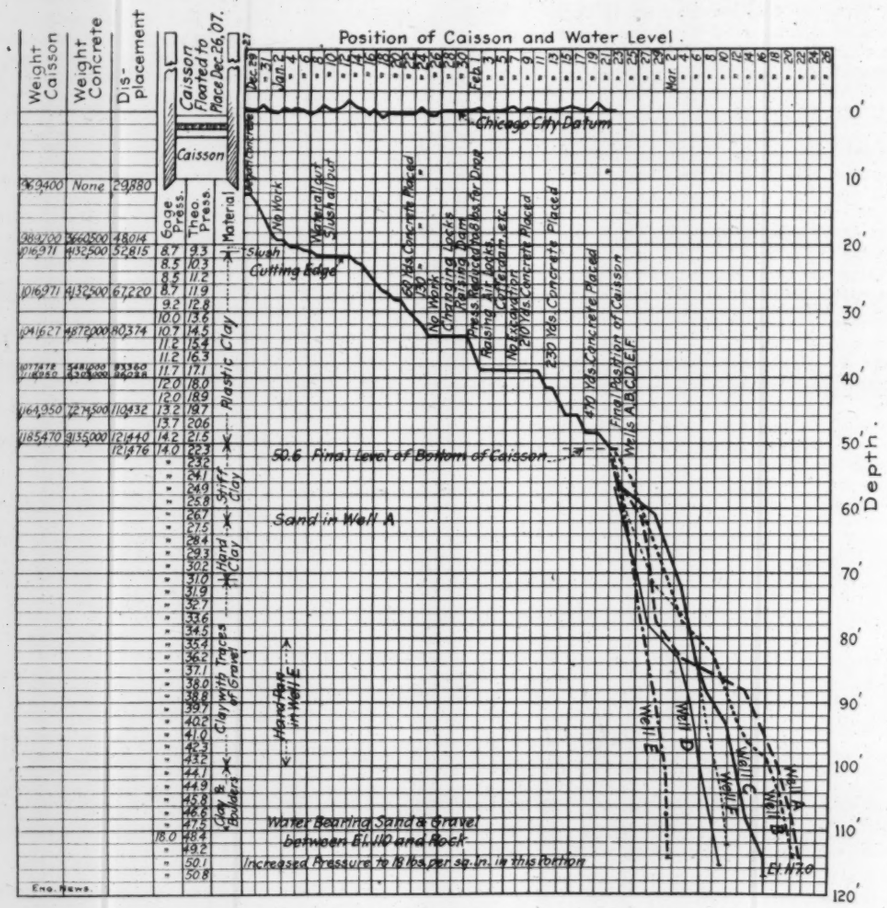


FIG. 3. DIAGRAM OF PROGRESS OF SINKING FOUNDATION WELLS FOR THE NEW KINZIE ST. BRIDGE.

to 60 ft. below datum were cut off at 18.95 ft. by a circular saw on a shaft suspended in the leads of a floating pile driver. An open caisson was built on land, sheathed with 3-in. plank, and having the bottom formed by a grillage of two layers of 12 × 12-in. timbers. The caisson framing was entirely independent of the grillage, and connected to the latter only by 28 vertical rods 1 in. diameter and 21½ ft. long. Concrete was placed in the caisson to sink it to the desired level. It was then towed to the site, anchored in position, and sunk upon the piles by the addition of concrete. Forms were then built to the neat lines and the concreting completed. The removal of the rods allowed the sides of the caisson to be disconnected from the grillage and taken off after the pier was completed. This construction is shown in Fig. 4.

The west abutment is 12 × 35 ft., containing 275 cu. yds. of concrete. The piles were driven to 60 ft. and cut off at 13.95 ft. below datum. The concrete was built in an open caisson. This abutment is anchored horizontally by 1-in. rods extending back to a row of piles 40 ft. from the bank.

For the protection or fender work, a double row of piles was driven around three sides of the east abutment and the rest pier. These were capped and provided with three lines of oak waling, and three sets of packing pieces between the rows of piling. Seven pile clusters protect the four exposed corners of the fenders.

Superstructure.

The new bridge is parallel with the line of the old bridge (now removed), with its center line 39¾ ft. south of that of the latter. It crosses the river at an angle of 69°, and provides a clear channel of 100 ft. as required by the U. S. Government. It provides also a waterway beneath the approach span. The structure consists of a double-track, through-truss single-leaf bascule span, and a 27-ft. plate girder deck span forming the west approach. The bascule span is of the Strauss trunnion type (Engineering News, Dec. 10, 1908). Its north truss is 170 ft. long c. to c. of bearings, and the south truss 162 ft. The difference in length is taken up in the west panel of the bridge, and by making the end bearings on a skew corresponding to that of the approach span and the dock lines. The trusses are spaced 29 ft. 10 ins. c. to c. The loading is the railway company's standard (Coopers E-50). An allowable stress of 15,000 lbs. in tension and nowhere exceeding 14,000 lbs. in compression is used for the main truss members. The completed bridge is shown in Fig. 5.

The trunnions are located in the upper chords, which are extended to form the tail of the truss which provides for the main counterweight bearing, 25 ft. back of the trunnions. The trunnions are steel forgings keyed into the truss bearings. They are 23¾ ins. diameter with an 8-in. hole through the center. The outer ends are supported by the main tower posts and the inner ends by the trunnion hangers. These four bearings are made on phosphor bronze bushings, 27 ins. long and 21¼ ins. diameter. The counterweight is a block of slag concrete reinforced with a heavy steel skeleton, and weighs approximately 1,247 tons. It is carried on two bearings (one at the tail end of each truss), and is maintained in an upright position by means of structural steel links connecting the top of the counterweight with the main towers.

The towers are connected above the trunnions by cross girders which support the trunnion hangers and form a support for the machinery, which is in an enclosure bracketed out to the rear of these cross girders.

The bridge is operated normally by two 50 HP. motors. They operate through an equalizer and train of gears to the main driving shafts, one on each side, supported directly by the towers. These shafts carry each a small pinion which engages the operating strut, which is a rack connected with the truss by a pin in the top chord at the first panel point riverward of the trunnions. A 10 HP. air motor is also provided as emergency power. This operates through a crab to the main motor shaft, the electric motors being disconnected while the gear is operated in this manner. The crab can also be operated by hand power but at a slow rate, and this is for use only in case of emergency. The controlling mechanism is in the operator's house bracketed out from the main tower about 30 ft. above the ground.

The track rails have miter ends which engage as the leaf is lowered into place. The bridge is locked by means of two lock bars which slide into guides fastened to each of the end shoes. These bars are connected by means of cross shafts, arms and worm gears with a small shaft running nearly the entire length of the span through the floor beams. On this shaft connection is made to a 3 HP. motor, controlled from the operator's house by a separate controller. This driving shaft also connects at the back end by means of worm gears cross shafts and arms with the wedges, operated direct connected with the locks. These wedges support the first panel point riverward from the trunnions, relieving the trunnions of most of the live load.

The weight of steel in the superstructure is about 800 tons, and the total weight on the trunnions is about 1,756 tons. The contract was let to the Toledo-Massillon Bridge Co., of Cleveland, O., which sublet the erection to the Kelly-Atkinson Co., of Chicago. Erection was commenced on May 17, 1908, and the bridge was put in operation for passenger trains on September 19, 1908.

During the first month of service this bridge was operated 983 times, an average of 31 swings in 24 hours, with a maximum of 41 swings in the same time. The railway traffic over this bridge during that month averaged 1,101 movements per 24 hours, distributed as follows: passenger trains, 303; empty coach trains, 230; passenger switching movements, 292; freight trains, 70; light engines, 206, total, 1,101.

Track and Interlocking.

On account of the new bridge being 39 ft. 9 ins. south of the old structure, the main tracks were shifted over to the new alinement and the switches were necessarily changed between the bridge and the Wells St. terminal. Work on track changes was begun in June, 1908, and all work possible, that did not interfere with the main tracks or the operation of the yard, was

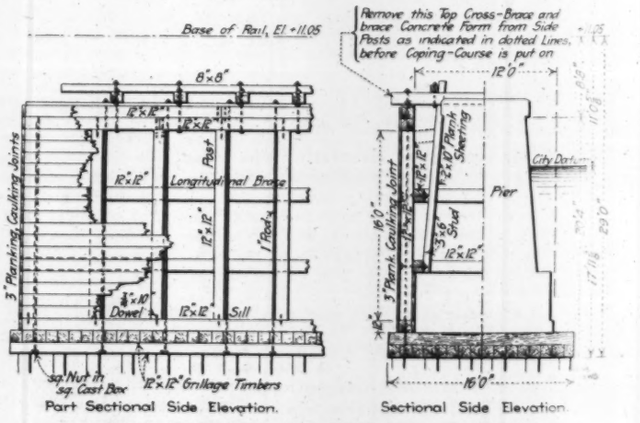


FIG. 4. REST PIER AND REMOVABLE CAISSON.

done while the new bridge was being erected. A regular schedule was made up, covering about six weeks preceding the final completion of the bridge, and outlining definitely when each change in tracks would be made and how long certain tracks would be out of use. The tracking of trains was rearranged according to this schedule. Both bridges were in service from noon until midnight on Sept. 19. During this interval the tracks were gradually connected up. Certain tracks were abandoned during Sunday, Sept. 20, but all passenger tracks were connected up for service by Monday morning, Sept. 21, 1908.

The interlocking plant at the Wells St. yard was changed to meet the new conditions. Formerly there were 65 levers in use, made up of 39 levers for 40 switches and six double slip switches; and 26 levers for 59 signals. With the new layout there are 67 workink levers; 39 levers for 44 switches, 4 double slip switches, and one single slip switch; 27 levers for 62 signals; and one lever for bridge locks. The changes in the machine were made between 4 p. m. Saturday, June 19, 1908, and the following Monday morning.

While there were but few additions to the machine, practically the entire locking was changed, amounting to almost a new plant. The switches

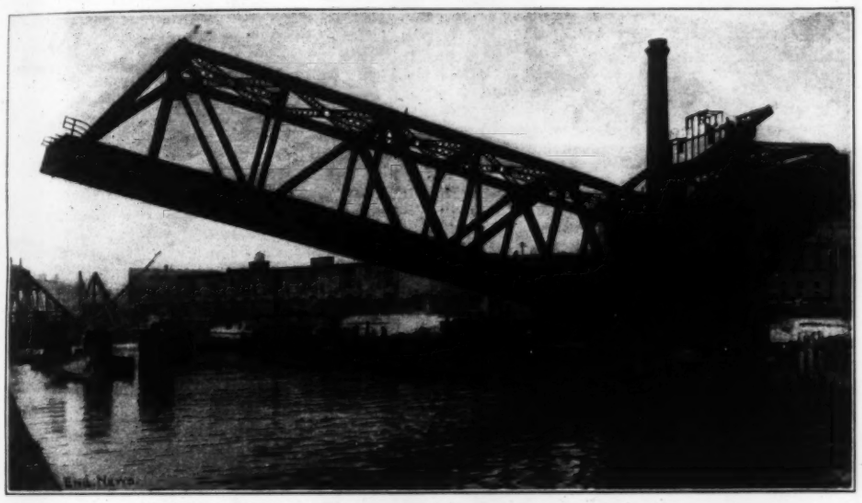


FIG. 5. NEW TRUNNION BASCULE BRIDGE OVER THE CHICAGO RIVER AT KINZIE ST.; CHICAGO & NORTHWESTERN RY.

controlled are electro-pneumatic, and the changes made it necessary to tear out and relay practically all air pipes and cables. Three new submarine cables and two new air pipes were laid under the Chicago River. All of the interlocked switches in the yard, excepting four, were changed in location and were rebuilt principally of new material.

All plans of this work, except those for the superstructure, were made in the Chief Engineer's office, under Mr. J. F. Stern, M. Am. Soc. C. E., Engineer of Bridges. Mr. W. L. Curtis had charge of the work in the field.

THE SPECIFICATIONS FOR COAL for the city of Chicago, as prepared by the Department of Public Works, provide for the use of the short ton (2,000 lbs.) and for the determination of the price according to the heat value of samples tested at the city's laboratory. Two formulas are included in the contract. The first provides for determining (A) the number of British thermal units for one cent; the second is for determining the price, and uses the result or quotient of the first as a divisor. The contractor guarantees a certain heat value (B. T. U. per lb. of dry coal); also the percentage of ash in dry coal, and the percentage of moisture in the coal as delivered. The formulas are as follows, the B. T. U. being per pound of dry coal, the price per ton being in cents, and the percentage of ash being expressed in cents:

$$A = \frac{\text{B. T. U.} \times \%\text{ dry coal} \times 2{,}000}{\text{Price bid per ton} + (0.3 \times \%\text{ ash})}$$

$$\text{Price} = \frac{\text{B. T. U.} \times \%\text{ dry coal} \times 2{,}000}{A} - 0.5 \times \%\text{ ash}$$

City and State Boards of Health and the Proposed Federal Department of Health.*

By M. N. BAKER.†

A vigorous campaign for a Federal Department of Health has been conducted during the past two or three years. One notable feature of this campaign has been the nebulous ideas of most of the campaigners regarding the ultimate work to be undertaken by such a department. Even more notable has been the way in which the promoters have practically ignored the boards of health which already exist in every State of the Union, in every city of consequence and in thousands of minor cities, villages and even in rural townships.

I hardly need say to the members of the National Municipal League that the first step in promoting any legislation should be to form a clear conception of what needs to be achieved and the second to survey the field in order to see what forces already occupy it and whether they should be supplanted or reinforced. Since the federal government cannot supplant state and city boards of health it is obvious that it can merely reinforce them or supplement their work. The fundamental question is, How? In what portions of the health-protective field and by what means?

For the purpose of simplifying and stimulating discussion I shall assume that public-health work is primarily local in character, and that the state should intervene only when the municipality fails to do its duty to itself or to its sister municipalities; or where municipal activities would overlap territorially and lead to duplication and possible conflict; or where research or other investigational work is beyond the scientific and financial resources of the smaller municipalities; or where great economies can be secured through centralized rather than scattered efforts. I also assume, for purposes of argument, that the nation should take a hand in health work only where and when a state and its minor civil divisions, through one limitation or another, fails to protect citizens outside its own boundaries, and when and where it can act on the broad general Constitutional grounds of interstate commerce and a limited application of the general welfare principle.

Broadly speaking, the state can regulate or even administer local health work wherever in its wisdom or lack of wisdom it sees fit to do so, quite regardless of whether the work in question is state-wide or purely local; but the nation can take no hand, at least not until after invitation, in health matters which affect only a single state. This difference between one of the several states and the United States should always be borne in mind when considering the proposed Federal Department of Health.

Let us now consider briefly the nature of public-health work. For the sake of definiteness and to promote discussion I shall again take for granted some things which many hold to be open to debate, and shall assume that for some time to come really efficient boards of health will concern themselves chiefly with the prevention of the spread of communicable diseases and the reduction of infant mortality by these and other means. This may be taken to mean research and educative work, so long as either is public rather than private in character. To be more specific, the major part of the everyday work of most boards of health, work which can be measured in some degree by its effect on statistics of sickness and death, has to do with the control of persons suffering from scarlet and typhoid fever, diphtheria, tuberculosis and the like, the protection of water, milk and other food supplies from infection by such persons, and likewise the protection of well persons from infection through any possible failure to control infected persons.

I boldly assert that if every case of communicable disease were promptly reported to the proper local board of health and as promptly placed under effective sanitary control and so kept until danger of infection had passed, all the other present-day activities of boards of health, whether local, state or national, with the exception of those directed against certain causes of infant mortality, and the possible further exception of some food and drug inspection, might be dropped with no appreciable effect upon the general health or mortality of any of our states or most of our cities.

If this be true, then health-board work, at least as now carried on, is essentially local in character, as I have already urged, and should be conducted, and where necessary improved, by the municipality rather than the state, much less the nation. The state may very properly do much to aid and even to force the municipality to act promptly and efficiently, but without local interest and intelligence the state can achieve little and the nation almost nothing compared with what needs to be and might be done.

I may interject, in passing, that even if the work of boards of health were to be enlarged, as many think they should be, to include a large amount of general and perhaps somewhat vague health-protective work, ranging from such public measures as smoke and noise prevention to such personal benefit as providing food and clothing for needy school children and free medical service to young and old, yet health-board work would still be essentially local in character.

In view of the foregoing facts and opinions I would therefore suggest, as a basis for discussion at this time, and perhaps for consideration by this committee during the year, that the primary responsibility for health work be placed squarely upon the municipality, but that the supervisory powers of the states be increased so they can hold their respective cities and towns to the strict fulfilment of their duties. I would also suggest that most of our states be given enlarged responsibilities, powers and facilities for the sanitary control of water, milk and general food supplies common to more than one municipality, and that the states be given increased facilities for research and educational work, the latter to include publication and popularization of the results of not only its own work but also of the best of the instructive work of local boards.

As for the federal government, I would suggest, again for purposes of discussion rather than as my own final opinion, that for the present its health activities be somewhat closely limited to those interstate fields in which the states are largely powerless, particularly to the sanitary protection of interstate water, milk, meat and other food supplies, including milk and meat from tuberculous animals; and also including the sanitary control of interstate railway cars and passengers.

The federal government might also very properly carry on health-research work of truly national importance. Such research work, and also the dissemination of the practical results achieved, might perhaps well be conducted jointly with state boards of health, and under special circumstances with local boards.

In emergencies the federal government might aid states or municipalities by detailing epidemiologists or giving laboratory assistance or expert advice. It might be well, however, to limit federal aid to municipalities which apply through their state board of health, possibly with power to apply direct in stipulated exceptional cases.

None of my remarks are designed to be unfriendly to the general movement for a Federal Department of Health (or perhaps, better, a Bureau, as was originally proposed). Personally, I heartily favor the general purport of Senator Owen's bill for a Department of Health, now before Congress. That bill proposes little more than a consolidation of the many uncorrelated health activities now carried on by various departmental bureaus. Such consolidation is highly desirable. But if the work already being done is to be reshaped, and perhaps curtailed here and increased there, it should be remodeled in accordance with a definite scientific plan, after taking full account of what is already being done in the health-protection field by fifty states and thousands of municipalities, and with a clear conception of the health functions which may legally and wisely be assumed by the federal government.

*Presented before the National Municipal League, at Buffalo, N. Y., Nov. 15, 1910.

†Chairman, Committee on Municipal Health and Sanitation, National Municipal League.

STEEL SLEEPING CARS have been placed in service on the Chicago, Milwaukee & St. Paul Ry. on trains between Chicago and St. Paul, and Minneapolis, between Chicago and Kansas City, and between Chicago, Marquette and Houghton, Mich. The Chicago, Milwaukee & St. Paul Ry. own and operate their own sleeping cars.

A Buttressed Masonry Dam Reinforced with Steel I-Beams.

By F. S. TAINTER,* M. Am. Soc. C. E.

An interesting type of dam, on practically new lines, has been built at a point on the south branch of the Raritan River, about one-half mile north of the village of High Bridge, N. J., for the purpose of extending and increasing the power of the Taylor Iron and Steel Co., who, before its construction, were obtaining their water power from a pond held in check by an old rock and earth-filled crib dam, built in 1858. The spillway of this ancient structure, although in a remarkably good state of preservation, had begun to show certain signs of failure, and was deemed unsafe to carry the additional head which was greatly desired. It was determined to build a modern dam carried to a height at crest some 4 ft. above that of the old. To that end careful surveys were made, and soundings taken, and as a result it was decided to build directly in front of the old dam, at which point a good quality of granite was indicated entirely across the river bed at an average depth of about 8 ft. During construction, the old dam was kept intact, thus doing away with the necessity of a cofferdam, except for the purpose of protection against back water.

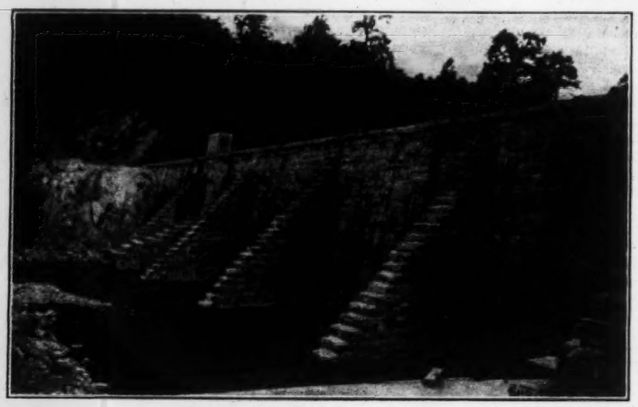


FIG. 1. BUTTRESSED MASONRY DAM AT HIGH BRIDGE, N. J.
(View of downstream face before water was let in behind dam.)

The type of dam designed and built was, as shown in the accompanying figures, a curtain wall supported by buttresses. The dimensions are as follows: Length of spillway, 210 ft.; height of dam, 42 ft., or from crest to lowest footing in rock, 55 ft.; thickness of wall at crest, 4 ft.; thickness of curtain wall at base, 16 ft. Buttresses are 6 ft. thick, and are spaced 30 ft. c. to c., with their toes projecting 10 ft. beyond the point cut by resultant of all forces acting on the section, as projected from measurements first given.

The outside appearance of the dam, as shown in photograph, is that of a heavy rubble structure, and indeed, to a great extent it does not sail under false colors. The rubble walls, however, were used for two reasons—first, because the adjacent country is granitic, and therefore furnished good building stones at reasonable cost; and second, because experience had shown the designer the advisability of avoiding, if possible, the costly form work necessary for concrete. The outside of the structure was therefore laid up in a heavy rough rubble, with carefully broken joints, and capped with a coping of cut stone extending entirely across the spillway. The buttresses and abutment were stepped back as shown in Fig. 1. In the core or hearting of both curtain wall and buttress was carried a heavy filling of concrete, made of a 1:3:5 mixture, so placed as to thoroughly bond with the outside rubble walls, which were really regarded as forms, and to ensure as far as possible against porosity. Just how well this was guarded against can be judged from the fact that although subjected to several trying floods since erection, a single crack, spurt or leak has yet to be noted.

*Member of Firm, E. A. Stevens & Co., Hoboken, N. J.

The novel feature of this structure was suggested by a dam built a few years ago for Mr. Andrew Carnegie at Princeton, N. J., by the writer as Constructing Engineer, in collaboration with the late J. J. R. Croes, Past-President Am. Soc. C. E., in which structural steel was used, as far as is known, for the first time in this character of work. In the Princeton dam, I-beams were used embedded in concrete at points where great rigidity of wall was desired, but in the dam now being described, heavy I-beams were used, as shown on drawings, to form a steel skeleton or frame work, carrying entirely through the hearting or concrete core.

Beginning at an elevation of about 1 ft. below bed rock, on which the dam was founded, was laid a line of 24-in., 80-lb. I-beams, completely embedded in, and surrounded by, the concrete matrix contained between the outside envelope of rubble walls. These beams were laid so as to break joints immediately behind the center line of each buttress, at which point they practically abutted. They were laid on the flat on the compression side of the dam. Immediately in front of the joint on the center line of each buttress, was laid a 10-ft., 24-in., 80-lb. I-beam, also on the flat in such a manner as to straddle or overlap the longer beams by 5 ft. in each direction. In front of this short beam was placed a 12-in., 40-lb. I-beam on end, that is, vertically, with the long axis of its web pointing down-stream, and from its center was placed a beam on its flange, reaching out into the hearting or core of the buttress wall. At a point 4 ft. up vertically from the second tier of 24-in., 80-lb. beams was laid another line of 20-in., 65-lb. beams. This, as shown in the drawings, was repeated at intervals, and in diminishing sizes and weights, until the last 12-in., 31.5-lb. beam was placed at elevation 297.8.

The essential feature of this steel frame, or skeleton, is that it is adapted to carry in compression all loads imposed on the structure. The frame or skeleton, as shown, forms a series of (theoretically) horizontal arches, so proportioned in length and weight as to be always inside of any deflective movement, supported or held at each end by buttresses, abutments or stiffeners in such a manner that the entire thrust or reaction is safely and evenly distributed and taken up. The well-built rubble walls and the concrete with which the beams were entirely surrounded and enveloped were ample protection against corrosion, and great care having been taken to encase the steel in a dusting of neat cement and very rich concrete, from which the air had all been expelled and driven out, the danger of corrosion was minimized, if not eliminated.

The normal or ordinary overflow was carried over a natural spillway of rock, slightly depressed below the granite covered spillway of the dam proper, the comparative elevations being 300.6 versus 301. The length and arrangement of this rock spillway will be noted on Fig. 2, the idea being obviously for the purpose of taking care of all usual or casual overflow, the dam proper only carrying flood water.

It will be understood that the only dams in the world which have long stood the test of time are of solid masonry or equally heavy material, and it is also a noteworthy fact that all of the structures of antiquity which have endured for centuries, cary their loads wholly in compression. Therefore, by analogy with these great structures, the principle just described is theoretically and practically correct, and particularly so when the fact is emphasized that the use of the most modern and strongest of materials is merely to save bulk, and effect economy. Direct comparison with the solid gravity dams show this type to effect a saving of 40% in bulk and excavation; about 40% in cost, and over 50% in time of construction.

The dam just described was started on July 31, 1909. The force of men employed on the work never exceeded 40, which comprised ten masons as a maximum. It was completed on Dec. 22, 1909, and on Dec. 27, 1909, it carried the record freshet of that vicinity (Fig. 3). The work was executed by the Taylor Iron and Steel Co.'s own force of men, acting under orders of the Engineer or his representative. The unit cost of the work was $6.92 per cu. yd., with charges of every nature considered.

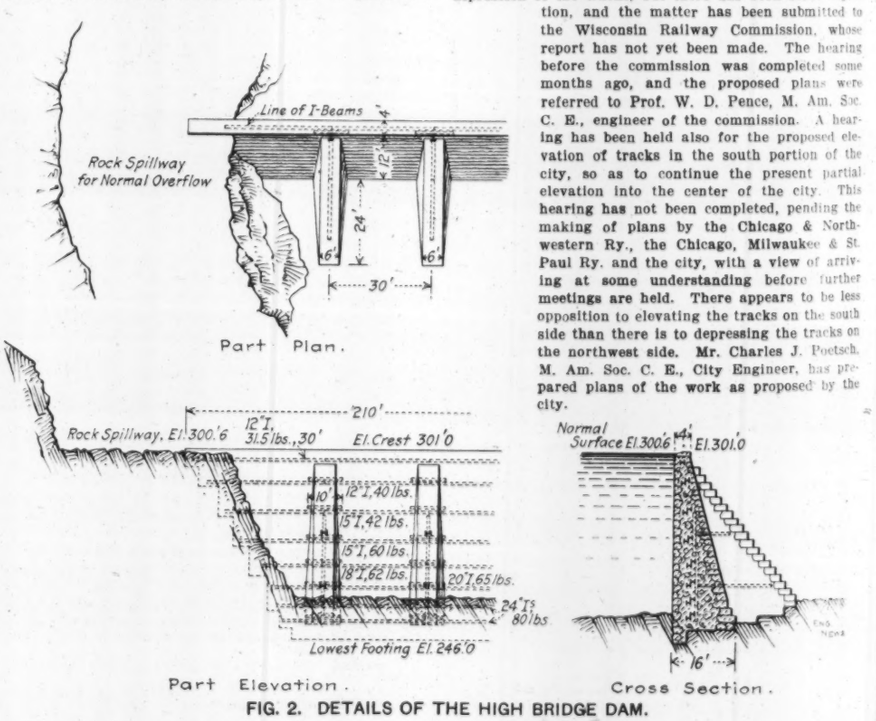


FIG. 2. DETAILS OF THE HIGH BRIDGE DAM.

GRADE CROSSING ELIMINATION by depression and elevation of railway tracks is proposed at Milwaukee, Wis., as an extension of work already done. The plans for work in the northwest portion of the city provide for depression of the tracks, but there has been some objection, and the matter has been submitted to the Wisconsin Railway Commission, whose report has not yet been made. The hearing before the commission was completed some months ago, and the proposed plans were referred to Prof. W. D. Pence, M. Am. Soc. C. E., engineer of the commission. A hearing has been held also for the proposed elevation of tracks in the south portion of the city, so as to continue the present partial elevation into the center of the city. This hearing has not been completed, pending the making of plans by the Chicago & Northwestern Ry., the Chicago, Milwaukee & St. Paul Ry. and the city, with a view of arriving at some understanding before further meetings are held. There appears to be less opposition to elevating the tracks on the south side than there is to depressing the tracks on the northwest side. Mr. Charles J. Poetsch, M. Am. Soc. C. E., City Engineer, has prepared plans of the work as proposed by the city.

Wind Loads On Mill Buildings.*

By ALBERT SMITH.†

Wind-pressures on mill buildings are handled by designers by various methods of distribution and application. Among the most common may be mentioned:

(1) No wind-panel loads are placed on the roof, the assumption being made that the wind will blow the snow off the roof and that the wind stress will not be greater in any member than the snow-load stress that it displaces. The column is designed for the maximum bending moment in the windward column, due to the wind reaction and a uniform wind load over its length.

(2) Horizontal panel loads from wind are placed both at the column panel-points and at the panel-points of the windward truss to get reactions and the stresses in the roof truss.

(3) Normal panel-loads, whose amounts are derived from the assumed horizontal pressure by empirical formulas, are placed on the panel-points of the truss and horizontal panel-loads on the column.

In all these cases, for fixed-end columns, the point of contraflexure in the columns is assumed to lie half way between the base and the foot of the knee-brace; this assumption is borrowed from the well-known proposition for a braced bent with a single horizontal load at the top.

The most evident objection that may be urged against the first method is that it leaves out of account a possible reversal of stress in some of the members of the roof truss. The second and third methods give knee-brace and column sections so large that many designers soften off the assumed wind-pressure as applied to these members, and thus get what they regard as an economical, as well as safe, design. A great many structures have resisted wind effects for many years whose stresses, if figured by any of the three methods, would seem to predict failure either in knee-brace connection or in column section.

In experiments made by Mr. J. O. V. Irmiger, of Copenhagen ("Engineering," Dec. 27, 1895) it was found that the suction on the leeward surface of a thin plate generally exceeds the pressure on the windward side, and that on the solid model of a building the suction on the leeward roof far exceeded the normal pressure on the windward roof. These experiments failed in producing any change in the assumptions for wind-loading on buildings because of the small size of the models on which the tests were made, and on account of the discrepancy between the 57% suction on thin plates found by Mr. Irmiger and the 33% found by Mr. Dines, another investigator in the same field.

In the hope of reconciling these differences and deriving data for accurate distribution of the wind-loads on buildings, Dr. T. E. Stanton, of the British National Physical Laboratory, in a series of tests on wind-pressure, included a very exhaustive examination of the pressures on a model of a building. This model was much larger than that of Irmiger, and the experiments were performed in the open air instead of in an artificial air current. The results indicated a considerable suction on the leeward roof and wall, but were far from checking with those of Irmiger. The most significant part of the result of Stanton's work as given before the Institution of Civil Engineers, Dec. 3, 1907, seems to be the experiments on the air-pressure on the inside of the building.

The maximum effect of the suction must be 14.7 lbs. and it seems more than probable that the increase of suction is not parallel to the increase of pressure. All the experiments so far performed have been in air currents of moderate velocity. It is to be expected that for velocities of 80 to 100 m. p. h. the ratio of suction to total wind effect would very greatly diminish.

For a long building, without open ventilators in the monitor, there exists a considerable suction on the lee roof and wall, which for a wind of 80 m. p. h. is assumed to lie between 6 and 8 lbs. per sq. ft. If this building were air tight in its walls and roof, assuming the total wind effect 20 lbs. per sq. ft., the panel loads on the leeward roof and wall would be derived from the suction, and the pressure on the windward roof and wall would be derived from the difference between 20 lbs. and the suction.

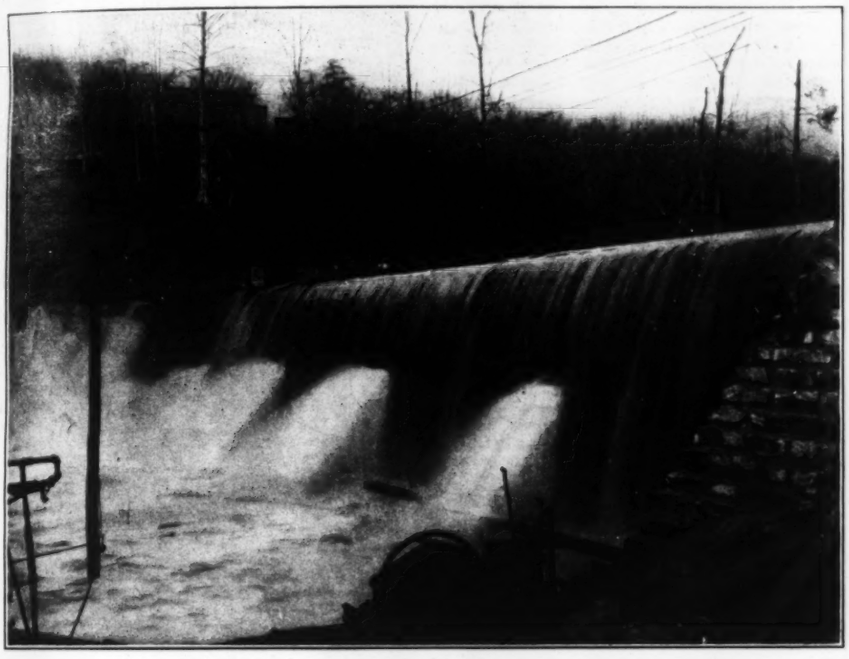


FIG. 3. VIEW OF DAM UNDER FRESHET FLOW OF DEC. 27, 1909.

The only case in which all the loads could be concentrated on the windward roof and wall, as is now generally done, is that where there is no leeward roof or wall.

In most buildings the openings are approximately the same in amount on the two sides, and the error from assuming them exactly equal should be small. If the openings on either side of the building can be assumed equal, when a steady wind is blowing, the discharge of air on the leeward side must be equal to the intake on the windward side. But this implies an equal difference between the inside and outside pressures on the two sides of the building. That is, the pressure on the inside of a mill building is a mean between the windward pressure and the leeward suction.

In the stresses in columns, it appears that a very considerable part of the maximum moment in them is due to the uniform load of wind. A reduction in the amount of this uniform load, from assuming one-half of it to act in the lee column, would cause a material reduction in the maximum moment. Most designers of mill buildings feel that a rigorous application of the more common assumptions in text-books gives column sections that are unreasonably large. Many of them have adopted assumptions that give results which they regard as reasonable, some of which assumptions are utterly indefensible on mechanical principles.

The weakest point in our present assumptions in regard to mill-building stresses, apart from the question of where the loads are to be applied, is in the assumption that the point of contraflexure for fixed-end columns lies half way between the base and the knee-brace. A formula could be written, by the method of least work, which would give the point of contraflexure almost exactly. This would be very awkward of application for uniform loads on one side of the bent only, giving points of contraflexure at different heights on the two columns. Under the writer's assumption, however, the points of contraflexure would lie at the same heights, and the formula would involve no increase of labor in calculation of stresses.

The most striking change in the size of sections caused by the use of the writer's assumptions comes in the girts. The bending moment in all girts and hangers is cut in two if we assume the wind effect to be equally divided between the two walls.

Whatever doubt may exist as to whether we ever get the wind-pressure assumed on a bent as a whole, there can be little doubt that the small area carried by a single girt is certain to be called on to resist at times more than our assumed load. Nevertheless, there are many cases of single-angle girts in buildings with good exposure which have successfully endured their wind-loads, although the wind-load ordinarily assumed would stress them beyond the elastic limit of the material. It has been urged, as explaining the endurance of such girts that they act as a string, after a certain amount of deflection has taken place. But (as Mr. Paul Stewart, of the Illinois Steel Co., pointed out to the writer) if this string-action is of such amount as to appreciably relieve the stress in the girt, the connection rivets of the girt would have to take a horizontal pull for which they are quite inadequate.

In buildings having open monitors the pressure within the building is somewhat reduced. Where the size of the stream of air passing through the louvres is large in comparison to the size of the building, it is probable that even with the slowing of its movement caused by the inclination of the louvres, it will retain enough velocity to diminish the inside pressure.

A very important application of the method discussed here is in three-hinged arches for drill halls and auditoriums. The reversal of stress which takes place in the leeward trusses would be very likely to cause failure.

In train-sheds, since one end will be open to the wind, the largest wind-stress on the truss members may be found when the wind is quartering on the open end of the structure. Here the inside pressure is a function of the angle of inclination of the wind with respect to the end plane of the building and the amount of the normal pressure. The normal pressure on surfaces inclined at 45° has been determined as equal to the pressure on a normal surface, and we should have, for the wind thus directed, the same panel-loads on the windward side as for the wind normal to the length of the shed on the vertical portions of the roof, but diminishing more rapidly toward the peak.

These panel-loads are counteracted by loads due to the inside pressure, giving resultant panel-loads which increase from zero on the vertical surfaces to an outward pressure at the peak, equal to the total wind effect. On the leeward side, all panel-loads are outward and equal to the full amount of the normal wind-pressure on the area. Where the vertical wall is high, such loading would give very high compressive stresses on the bottom chord of the leeward truss.

The making of accurate tests on the effect of the wind is a very difficult matter and the results must be applied with many reservations, since they are strongly colored by the character of the exposure.

The specification of 20 lbs. per sq. ft. of wind-pressure, being the effect of a wind of about 80 m. p. h., seems to be quite safe for mill buildings in most cases. Indeed, there are many cases in which it might safely be reduced; places where the velocity at the surface of the earth is certain to be less than that at the heights at which velocity readings are taken. But there are also positions in which the exposure is so unfavorable for the building that it would be only prudent to increase the assumed pressure.

In conclusion, the writer advocates: (1) Placing the wind loads equally on the two walls, and inward and outward on the windward and leeward roofs respectively, as giving important changes of stress in members of the roof-truss, as giving less stress in the knee-braces and columns, and as permitting the rational design of the girts.

(2) An accurate determination of the point of contraflexure for fixed-end columns.

(3) Making the amount of the wind-pressure for a given building a matter to be decided in the light of the exposure of that building.

If some, while admitting the general truth of the premises of these points, object because they involve an increase in the labor of the engineer, it may be urged that a ton of steel will pay for many hours of engineering labor.

*Abstract of a paper read before the Western Society of Engineers, Nov. 9, 1910.

†Associate Professor of Civil Engineering, Purdue University, Lafayette, Ind.

THE GRAND TRUNK PACIFIC RY., forming the western portion of the Canadian Transcontinental Ry. (noted in our issue of Nov. 3), will have a total length of about 1,745 miles from Winnipeg to Prince Rupert, the Pacific coast terminal and port. Of this total, 1,029 miles are completed, and the remaining 716 miles are under construction or under contract.

The Agricultural Use and Value of Sewage.*

By J. A. VOELCKER,† F. I. C.

THE FUNDAMENTAL DIFFICULTY.—It is clear that if the practice adopted in China and in many parts of India, of collecting the excreta daily and depositing them direct in the soil, were followed universally, there would be the minimum of loss and the greatest profitable return in the subsequent growing of crops. But such procedure is nowadays out of the question in this country, and even the use of the earth-closet system is so little practicable that it does not enter seriously into consideration. All such systems as these have had to go "by the board" in favor of the water-carriage system, and it is this alone which we need here treat of. At the same time there is no question but that where the pail system is still in operation there will be the best return in an agricultural direction. Such a system, however, is quite incapable of dealing with trade and manufacturing refuse. Whatever the agricultural benefits arising from the use of sewage may be, these have had necessarily to give way to the claims of the speedy transmission of objectionable matter from closely-populated areas. This has brought about a new set of circumstances which have seriously interfered with the realizing of any value from the use of sewage in an agricultural direction. How this affects the question it will be for us now to consider.

Hindrances to Sewage Farming.

HIGH DILUTION.—The main difficulty is with regard to the water, this constituting by far the largest factor in sewage. The first effect of the water is to enormously dilute the constituents which possess fertilizing value. So marked is this that it may be said that the total amount of nitrogen in the sewage of water-closet towns does not on an average exceed 2.2 parts per 100,000, or .0022%. As the amounts of phosphoric acid and potash yielded from excreta are even less than the nitrogen they would not amount to, on an average, more than .0013% of phosphoric acid and .0009% of potash. The passage of so much liquid, presuming the sewage to be poured over the land in a crude, untreated state, would, in most cases, necessarily mean the passage through the soil of a large proportion of the soluble constituents which the soil would be unable to retain and which would be lost in the drainage water.

To what extent this loss would proceed would depend, of course, on the nature of the soil, and on the area of land available for irrigation purposes; but it is seldom in practice that the area is sufficient to allow of the dealing on it of the sewage in such a way as to secure the maximum benefit and the least loss. The nitrogen in raw sewage, as we have seen, is seldom in the form of nitrates (that in which it can be freely taken up by plants), but requires to be converted into nitrates by nitrification. This latter process depends for its successful working on various conditions being present. Chief among these are a suitable temperature, abundant aeration, and the presence of some base, such as lime.

NITRIFICATION IMPEDED.—Land on which sewage is being constantly poured has a marked tendency to become cold, and aeration is much impeded when the land is in a state of saturation. The circumstances, therefore, are not favorable to nitrification proceeding freely whenever the soil is, as generally happens, taxed to its utmost to deal with the liquid poured on its surface. Nitrification, at the best, only goes on in the first 16 ins. or so of soil, and even in the case of land which has been at rest and where nitrates may have formed, the inflow of large volumes of water will have the effect of washing out a good deal of the nitrates so formed. Thus it is that nitrates form comparatively so large a proportion of the constituents of drainage water from irrigated lands. Again, nitrification is very little active during the winter months, and crops are but little able to avail themselves at this period of the nitrogenous matters contained in sewage. When no crops are growing on the ground the soil becomes little more than a filtering medium, and it is only a small proportion of the fertilizing constituents that can be retained by it. In the case of a soil that is at all waterlogged, denitrification rather than nitrification is likely to result.

CHOICE OF CROPS.—When, however, crops are being grown on the land, and the conditions are kept reasonably favorable for their culture, the losses are less and the return more marked. But here, again, care has to be exercised in regard to the kinds of crops grown, and it is essentially those of a succulent nature, such as mangolds, cabbage, prickly comfrey and rye grass, which should be employed. Such crops, by their rapid nature of growth and the avidity with which they take up soluble constituents supplied to them, are well suited for the purpose, though, in respect of quality and feeding value, they will fall below those cultivated on dry land. Out of the large quantity of food constituents supplied, some quantity, however, will be taken up by the quickly-growing crops, and this is the best means of utilizing them. Much the same applies to sewage when poured over grass land, the abundant rooting of the grasses helping to retain the constituents much more completely than is the case with arable land. On the other hand, inasmuch as the grass only makes a start to grow in the spring, it is from this time only that the benefit is really shown, though no doubt fertility is being built up in the soil at other periods, and the losses by drainage are not so great.

LAND CLOGGING.—Where sewage is poured untreated over the land a further difficulty is met with in the tendency of the fatty and soapy matters carried down with it to collect together and form an impervious scum on the surface. When this occurs it is fatal to successful cultivation and the only remedy is to give the land a rest and to break up or remove the scum. If such scum be formed, not only is the further passage of the liquid through the soil prevented, and clogging of the land results, but aeration is entirely stopped and nitrification brought to a close. The same effect would be produced by the continual pouring on the land of brewery waste, and the like. Some sewages, more particularly those in which the waste from the manufacturing processes forms a considerable proportion, are decidedly acid in nature, and when this occurs a state of affairs unfavorable to bacterial changes going on in the soil is produced. Also, where chemical agents have been used as precipitants, materials are frequently brought on the land which are in no way beneficial from an agricultural point of view. Their presence, further, retards the desirable decomposition of the different organic and nitrogenous matters brought on to the land.

Soils vary considerably in regard to their suitability for dealing with sewage poured on to them, and, while some, such as heavy clays and peaty land, are quite unsuitable for irrigation purposes, others, such as rich loams, may be well adapted thereto and sand loams and even sands be capable of successful utilization. The last named, however, will not so readily retain the constituents of the sewage, nor bear such good crops, but act rather as filtering media. In treating land in this way, the ideal is to allow intervals for aeration and oxidation, and so avoid stagnation and the stoppage of the natural processes going on in the soil.

PRELIMINARY PROCESSES AND THE SLUDGE PROBLEM.—The difficulties connected with the clogging of land when crude sewage is turned on to it have mainly resulted in the adoption of processes of chemical treatment with the object of removing the suspended matters and those capable of precipitation which are contained in sewage. From an agricultural point of view, however, the value of the sewage is thereby considerably reduced, inasmuch as the phosphates are, to a large extent, removed, as also are the nitrogenous bodies such as proteins; the amides and ammonium salts, however, pass on in the liquid portion.

There is then left the difficulty of dealing with the solid matters, or "sludge," as it is called, and this constitutes a real difficulty. Efforts have been made to get rid of it in various ways, including the digging of the solid matters into the ground, or the pressing of them with lime into cakes and allowing these to dry for subsequent breaking up and use as manure. None of these methods, however, have been really successful. The wet sludge when dug into the ground remains long unaltered and blocks the soil, rendering drainage difficult and cultivation unsatisfactory. The accumulation of sludge further constitutes a source of nuisance and possible danger, inasmuch as bacteria are found to be far more abundant in the sludge than in the liquid sewage, and to increase largely at the ordinary temperature of the air.

Later on the trouble in dealing with sludge was to some extent minimized by the adoption of the "septic tank" system, but even this does not succeed in getting rid of the sludge entirely, and the best process with which I am acquainted is that introduced by Mr. Dibdin, and known as the "slate bed system," whereby the sludge is reduced almost to a minimum, and, by reason of the bacterial changes which it is made to undergo, is converted into a harmless and almost inodorous material, the disposal of which, owing to its character and the very small amount of it that is produced even under continuous working of the beds, presents no difficulty.

Manurial Value of Sewage in its Different Forms.

THEORETICAL VALUE DISAPPEARS IN PRACTICE.—From what has been already said, it may be gathered that, in my opinion, the manurial value of sewage, as it is now generally met with, and whether it be in the form of crude sewage, of sewage deprived of its solid matters, or of sewage sludge, is but very small. Theoretically, it may be rightly said that great loss to the country is being incurred by the letting run to waste material representing so large a proportion of the food consumed by human beings, and which ought to be returned to the land and come back again in the form of crops. More especially is this urged when one considers the high prices paid for fertilizing materials, more especially nitrogen, at the present time, and in view of the forebodings that have been expressed as to the failure, in the near future, of our nitrogenous supplies. But these theoretical considerations have had to give way to the exigencies of modern-day life and despite the views that have been held in the past, and the many attempts to "make something out of" sewage, the last report of the Royal Commission on Sewage Disposal recognizes the fact, now established, that farming results with sewage have to hold quite a "secondary position."

SLUDGE EXPERIMENTS.—Quite recently, however, experiments have been carried out with sewage sludges, made by different processes, on actual crop growing, but with the result of showing that the manurial value of these has been very much exaggerated, and that even for the best of them, though carefully prepared and dried, 10s. a [long] ton [$2.18 per short ton] represents the full value. It had long been an article of belief, even among scientific men, that there was some "virtue" attributable to so much organic matter capable of undergoing bacterial changes, which virtue was not to be represented merely by the contents of nitrogen, potash, phosphoric acid, etc., as expressed in analytical figures.

These beliefs were not borne out by the experiments made, though these were conducted on a variety of crops and on different classes of soil, and though the experiments were continued for a second year, so as to give an opportunity of the effects telling at a later period, the sludges in no case did as well as did artificial manures containing practically like quantities of fertilizing ingredients. The striking point was, however, clearly brought out that the nitrogen in the forms in which it occurs in sewage sludge is not nearly so available as in artificial manures, and that richness in nitrogen is not a test of the comparative value of sludges. Nor, again, would freedom from moisture seem a desideratum; the sludges that answered best were those that contained the most lime, the most moisture, and the least nitrogen.

Undoubtedly, on certain soils, such as those of heavy nature, and those poor in vegetable matter, sludge may effect a benefit from its mechanical action on the soil and in improving its physical properties; but it is clear that its directly manurial benefits, as well as those of sewage itself, have been very considerably over-estimated.

*Portions of a paper read before the Association of Managers of Sewage Disposal Works at Northampton, England, July, 1910.

†Consulting Chemist to the Royal Agricultural Society of England.

AN ENGINEERING COURSE IN 1875, at the Ohio State University is given as below in a recent bulletin:

FIRST YEAR:

Human Physiology,	Structural Botany,
English Language,	Physical Geography,
Algebra,	Geometry,
Systematic Botany,	Military drill and tactics.

SECOND YEAR:

Physics,	Military drill and tactics.
Zoology,	Chemistry,
Plane Trignometry,	Geometry,
	History.

THIRD YEAR:

Surveying,	Spherical Trigonometry,
Descriptive Geometry,	Analytical Geometry,
Navigation,	Isometric Drawing;
Astronomy,	Spherical Projections,
Shades and Shadows,	Perspective.
Military drill and tactics,	

FOURTH YEAR:

Calculus,	Roads and Railroads,
Mahan's Civil Engineering,	Geodosy,
Bridges and Bridge Drawing,	Stone Cutting,
Walls, Arches, etc.,	Military drill and tactics.

WHAT IS CLAIMED TO BE THE LARGEST PAPER map ever made has recently been placed in the directors' room of the Missouri Pacific Ry. Co., 165 Broadway, New York. The map is 35 ft. high by 45 ft. long. On account of the extreme height and because it was desired to have the objective point at about the same level as the eye, this map was mounted on two rollers—one placed near the ceiling and the other near the floor, both being enclosed in cabinet work. The exposed face of the map at no time exceeds more than 12 ft., but any part of North America, from the Canadian border to the City of Mexico, can be seen by raising or lowering. This is accomplished by a sprocket wheel and handle which turns the rollers, and is also equipped with a brake. The map, which is plotted on Mercator's projection, shows the geographical divisions, such as counties; the topography of the country, such as mountain ranges, extensive swamps, lakes, rivers and creeks. All the railways of the country are shown and the scale, approximately 8 miles to 1 in., is so generous that the network of railway lines in Illinois stands out distinctly. This map was compiled and drawn by C. P. Gray, 130 Fulton St., New York City.

Other large maps which, however, are not especially accurate, being painted on cloth instead of drawn, include one in the Broad St. Station, Philadelphia, approximately 12 ft. high; one in the office of the American Express Co., in New York, which is somewhat over 100 ft. long. A map recently made of the Harriman lines includes the country west of Chicago and is 22 ft. long by about the same in height. Some large maps will be placed in the new Pennsylvania Terminal station, New York City, but these will be about 50 ft. above the floor line.

The Panama Excursion of the American Institute of Mining Engineers.

By W. L. SAUNDERS,* Vice-Pres. of the Institute.

The Canal Zone Meeting of the American Institute of Mining Engineers began on Oct. 21, 1910, and ended on Nov. 15. The steamer "Prinz August Wilhelm" of the Hamburg-American Line was chartered for the trip and the party consisted of 121 persons, most of them members of the Institute. There were 84 men, the balance being made up of wives, daughters and guests. (The list was published in Engineering News of Nov. 17.)

It is doubtful whether the Institute in any of the long excursions for which it has become famous has ever gathered together so representative a body of its members in any one excursion. There were no less than 36 colleges represented, and of the 84 men, 60 were college men. Columbia and Lehigh led with 10 representatives each, Harvard and the University of Pennsylvania following. Eighteen states were represented.

Metal mining was in evidence by the presence of such men as Hennen Jennings, Gardner F. Williams and H. C. Perkins, all of whom are veterans of the early South African mine development period. Mr. Williams was for some eighteen years the General Manager of the De Beers and Kimberley diamond mines. Messrs. Perkins and Jennings represent the Robinson and other Werner-Belt properties, the largest and richest gold mines in Africa. All three of these men have international reputations for high character and important achievement. The work they did in South Africa and the reputations they made there add to the prestige of American engineering, and they well earned the fortunes they have made. Other prominent figures in precious metal mining were R. B. Watson, General Manager of the Nipissing and La Rose mines at Cobalt, Ontario; W. E. C. Eustis, of Boston; A. C. Carson, of New York; Walter J. Page, Manager of the Guggenheim Smelters at Omaha; and Harry C. James and David G. Miller, of Denver.

Copper and other metal mining interests were represented by George D. Barron, C. W. Goodale, Manager of the Boston & Montana at Butte; William Kelly, General Manager of the Penn Iron and Republic Mines in Michigan; and David W. Brunton, of Denver, President of the Institute.

More than 50% of the anthracite coal producing properties were represented, among them being W. J. Richards, Vice-President of the Reading Coal & Iron Co., with a pay-roll of $20,000,000 a year, larger even then the pay-roll of the Panama Canal and with an equal number of men employed—that is 33,000. Others were W. A. Lathrop, President of the Lehigh Coal & Navigation Co.; S. D. Warriner, Vice-President and General Manager of the Lehigh Valley Coal Co.; R. V. Norris, of Wilkes-Barre; James S. Cunningham, of Johnstown, Pa.; H. N. Eavenson, Chief Engineer of the United States Coal & Coke Co., of West Virginia; Rowland F. Hill, of Pulaski, Va.; Eugene McAuliffe, of Chicago; Samuel A. Taylor, of Pittsburg; Philip Goodwill, formerly President of the Pocahontas Co., of West Virginia; W. S. Ayres, of Hazleton, Pa.; and F. W. Scarborough, of Richmond, Va.

Prominent men in other branches of engineering were Dr. Drinker, President of Lehigh University; Prof. J. W. Richards, of Lehigh; William Kent, Dr. R. W. Raymond, Charles Kirchhoff, Col. D. C. Dodge, the railroad builder of Denver; Edward W. Parker, of the U. S. Geological Survey; D. M. Riordan, David B. Rushmore, of the General Electric Co.; Dr. Struthers, Jos. Underwood, Thos. Robins, Howard Wood and Walter Wood, of Philadelphia; C. M. Russell, of Massillon, Ohio; and Frank M. Warren, of Minneapolis.

The party enjoyed perfect weather on the voyage from New York to Havana, notwithstanding the apprehensions felt at sailing on account of the recent hurricanes. An informal reception on Saturday, the first day at sea, helped to cultivate acquaintance. Much interest was excited by an exhibition made by Mr. Gardner Williams of diamonds taken from the Kimberley mines.

On Sunday, Oct. 23, a religious service was held in the dining saloon, conducted by Dr. Raymond, who has won laurels as a pulpit orator as well as a scientist and engineer. For the first time it was noticed that the eminent Doctor was a singer as well as a preacher, and on this occasion he sang with such zeal that his voice limited the length of his sermon to 20 minutes. At the end of the service the Captain of the ship called attention to the fact that the sea beneath us was two miles deep. In the afternoon Dr. Raymond repeated that delightful and instructive address on Jamaica which he gave at the New Haven meeting of the Institute. As the party was en route to Jamaica every one was eager to get information about the Island from a recognized authority.

The first session of the Institute was held on ship Monday afternoon, Oct. 24. President Brunton congratulated the Institute on the large number present and on the representative character of the gathering. Dr. Raymond read by title only the following list of papers, giving notice that some of these would be taken up and read or discussed at future meetings of the Institute.

Crushing-Machines for Cyanide Plants, by Mark R. Lamb.
Recent Progress in Blast-Roasting, by Prof. H. O. Hofman.
Labor-Saving Appliances in the Assay-Laboratory, by Edward Keller.
Method of Determining the Meridian from a Circumpolar Star at any Hour, by Eugene R. Rice.
Recent Developments in the Undercutting of Coal by Machinery, by Edward W. Parker.
Biographical Notice of Franklin R. Carpenter, by H. O. Hofman.
The Reduction of Calcium Sulphate by Carbon Monoxide and Carbon, and the Oxidation of Calcium Sulphide, by H. O. Hofman.
Tests of an Ilgner Electric Hoist, by R. R. Seeber.
Bibliography to Accompany Paper on Electric Mine-Hoists, by D. B. Rushmore and K. A. Pauly.
Biographical Notice of William Phipps Blake, by Rossiter W. Raymond.
Report of Committee on Uniform Mining Laws for Prevention of Mine Accidents, by W. R. Ingalls, J. Parke Channing, James Douglas, J. R. Finlay and John Hays Hammond.
The Gold-Fields of French Guiana, and the New Method of Dredging, by Albert F. J. Bordeaux, Thonon-les-Bains.
The Agency of Manganese in the Superficial Alteration and Secondary Enrichment of Gold-Deposits in the United States, by W. H. Emmons.
A Commercial Fuel-Briquette Plant, Discussion by C. T. Malcolmson.
A Commercial Fuel-Briquette Plant, Discussion by Robert Schorr.
Combustion in Cement-Burning, Discussion by Robert Schorr.
Manganese-Ore in Unusual Form, by W. P. Blake.
The Nicola Valley Coal Field, British Columbia; Postscript by Roberts.
The Limit in Economy in the Iron Blast Furnace, Postscript by Langdon.
Pyritic Smelting in Leadville, by C. H. Doolittle and Royal P. Jarvis.
The Laws of Intrusion, by Blainey Stevens.
Copper Blast Furnace Tops, by N. H. Emmons.
Genesis of the Leadville Ore Deposits, Discussion by Morton Webb.
Introduction of the Thomas Basic Steel Process in the United States, Discussion by Hibbard.
Dry Washing for Placer-Gold in Sonora, by J. V. Richards.
Mine Survey Notes, by George W. Riter.
The Solid Non-Metallic Impurities in Steel (Sonims), by H. Hibbard.
Theory of Dust Explosions, by Audley H. Stow.
The Combustion of Carbon, Discussion by Prof. William Kent.
Calculation of Sinking-Funds, Discussion by Frank Firmstone.
Crushing Machines for Cyanide Plants, by Herbert A. Magraw.
Recent Progress in Blast-Roasting, by James W. Neill.
Geology of Silver-Fields of Nipissing, Ontario, by Reginald Hore.

A general discussion was held on extinguishing mine fires. Mr. William A. Lathrop introduced the subject by referring to the fire at the Summit Hill mine of the Lehigh Coal & Navigation Co. Mr. Warriner, formerly General Manager of the Calumet & Hecla mines, explained how the fire in the Calumet & Hecla was extinguished. Mr. R. V. Norris described the fire at the Lykens Colliery, and W. J. Richards called attention to the fact that shutting off the air is sometimes more effective in putting out a mine fire than flooding by water. Mr. Samuel A. Taylor referred to certain fires in the Wyoming field which had been caused by crossing of electric wires. President Brunton spoke of the great fire at the Anaconda Mine, it being generally known that Mr. Brunton's skill contributed very largely toward the control of this fire. He described how futile were the attempts to extinguish the fire by water, as it was only by building bulkheads at intervals closer and closer to the fire that the territory was brought under control. An interesting statement in connection with Mr. Brunton's remarks was the description of how the men wore helmets, to which they attached hose which was connected with the regular compressed air pipe in the mine, this air not only serving to keep down the temperature but to blow away the smoke and noxious gases, enabling the men to reach places in the mine otherwise inaccessible. At these places stone walls were built blocking off the air. Mr. Brunton said that the men got so accustomed to the use of these air helmets that it was a common remark that with such an equipment a man might build a stone wall around Hell.

In the evening a general entertainment followed by dancing was given in the music room.

So favorable was the weather that the ship arrived in Havana on Tuesday, the 25th, so much ahead of time that the party of Cuban engineers who had planned to receive us were not on hand. A reception was given at the Plaza Hotel in the afternoon.

On arriving in Havana a group of enthusiastic mining engineers, one of whom prided himself on his Spanish, hired a cab and told the driver to show them the town. He drove to the hill back of Havana and pointed out from its summit the beautiful panoramic view of the city and harbor. Going on a little further the driver stopped in front of a stone mansion, where armed guards were marching, and exclaimed "Presidio." "Ah," said the M. E. who prided himself on his Spanish, "yes, I understand. This is the residence of the President,—presidio,—I know. What a beautiful spot and what a substantial mass of buildings!"

In the evening of the same day these men were received by President Gomez and they learned from the President himself that the presidio was the penitentiary.

The impression made upon every one was that Havana could no longer be looked upon as a dirty city; that it was distinctly clean and healthy. Little evidence was seen of the recent hurricane, which had done its greatest damage in the interior by the destruction of the tobacco crop.

On Thursday, the 29th, while en route to Jamaica, the Institute held another session on the ship, continuing the discussion on mine fires. This was participated in by Mr. Norris and Mr. Kelly. Mr. Kelly described four cases of fire, referred to the use of the fire helmet, and said that he had learned that as soon as an alarm of fire was sounded the first thing to do was to get the men out of the mine and then be sure not to use candles but acetylene lamps.

President Brunton said that in his experience with carbon-monoxide in mines a note of alarm is sounded when the danger point is reached, this being a tickling sensation in the forearm or in the legs, or both. As soon as this sensation is felt, one should get out of the mine as quickly as possible. Dr. Raymond read a letter from E. E. Ludlow, describing an explosion in the Pelawo mine in Mexico. Mr. Parker in discussing this case said that the explosion was probably due to the powder used,—a cheap dynamite, not one of the explosives included as permissible in the United States Government regulations; furthermore, all coal in that mine was shot from the solid, no undercutting being done. President Brunton referred to the fact that water in contact with certain sulphur ores in mine fires will generate great heat, thus being ineffective in extinguishing the fire. Gardner Williams described the great mine fire at the De Beers diamond mines, where 202 persons were killed. Hennen Jennings was introduced by Dr. Raymond as a man who had never had any mine fires. Mr. Jennings said that the Johannesburg mines were essentially safe from fire dangers, little timber being used. These mines have produced nearly £300,000,000 in gold. His story about mine fires would have to be like the treatise which the man wrote on the snakes in Ireland; namely, "there are no snakes in Ireland."

*President, Ingersoll-Rand Co., 11 Broadway, New York City.

On Friday morning, the 28th, the entire party indulged in field-day sports. Sober men, of mature years, who carry large responsibilities at home, could be seen in their shirt sleeves engaged in pillow fights across a spar which the Captain had strapped above the deck; or taking part in cock fights, races and a general tug-of-war.

Another session of the Institute was held in the afternoon, at which Prof. Richards, of Lehigh, read a paper on the Production of Pig Iron by the Electric Furnace in Sweden. A concert was held in the evening, one notable event of which was an original poem a la Ingoldsby Legends by Dr. Raymond.

Saturday and Sunday, the 29th and 30th, were spent at Jamaica, where we were greatly indebted to the courtesy of Mr. Meyer, the General Passenger Agent of the Hamburg-American Line, who accompanied the party throughout the trip, and to Captain Forward, the company's agent at Jamaica. The natural scenery of this island is so striking, its history so unique, and the natives so interesting, that visitors to the Canal Zone do well to stop en route at this interesting island, some of the mountain peaks of which are more than a mile high. The effects of the earthquakes are visible throughout Kingston, and also at Port Royal, once known as the wickedest city in the world.

From Jamaica to Colon is a two-day trip. The party was entertained en route by a parade of the "Kingston misfits" and other sports. Another session of the Institute was held on Monday, at which a general history and description of the Panama Canal was given by the writer, followed by an interesting address on Panama and its people by Mr. John M. Sherrerd.

Arrangements had been made to visit the Gatun Dam on Nov. 1, the day of arrival at Colon, but the ship's engine went wrong during the night, or, as stated on the blackboard the next day, "The fly-wheel jumped over the eccentric," hence the arrival at Colon was too late to follow the program. We were met at Colon by Col. Goethals and Admiral Rousseau, who took the train directly across the Isthmus to Panama. This journey gave us our first general view of the Canal, as the railroad follows the line closely. The first impression made upon the writer (whose last visit to the Isthmus was three years ago) was that great progress had been made in and about Gatun. Next it was plain that Lake Gatun was already a reality, for along the railway for miles the train ran through swampy places, where the water at times was over the rails, conditions that did not exist three years ago. This water is the result of the filling of the lake behind that portion of the Gatun Dam already finished, the limitation of height, as Col. Goethals explained, being the height of the spillway gates through which the Chagres River now discharges.

A part of this journey from Colon to Panama was over the relocated line of the Panama Railroad. A high tribute was paid to John F. Stevens by Col. Goethals, who said that the army engineers now building the Canal were not railway builders, and that Stevens had left them an inheritance in this relocation of the Panama Railroad which was very much appreciated and which aided much in carrying out the work.

A special train took us through the Culebra Cut on Nov. 2. The story was told of a Congressman who was taken to the bottom of the Gatun lockpit. Looking upward from the floors of that immense gorge between high concrete walls he said to Col. Goethals, "At last I may say that I have stood on the bottom of Culebra Cut. Will you now please show me the Gatun Locks."

The Culebra Cut, as we saw it, resembles a Colorado canyon. It is about eight miles in length and has been excavated at each end to within about 5 ft. of the completed depth. At the center about 70 ft. more has to be excavated. The walls of the cut rise in varying slopes on either side to a maximum height of about 400 ft. Huge slides are in evidence, one of them reaching back 1,400 ft. from the cut. The material affected by the slide is estimated at 3,000,000 cu. yds., about half of which has been removed from the cut. These slides are generally slow in movement, though occasionally a heavy and rapid fall of material takes place, one of the latter slides having buried a steam shovel.

The material of the Culebra Cut is the most unusual conglomeration of basaltic and sedimentary rock that has ever been seen in one place. It varies greatly in color, hardness and in chemical composition, these variations taking place at frequent intervals. No man can estimate when or where a slide will occur or how much material will work its way into the cut before it reaches the angle of repose. Col. Goethals in answer to the question, "What is the angle of repose?" said that the material had not stood still long enough for them to measure it and that it varied all the way from zero to 90°.

One could not stand at the bottom of this cut and view the uncertainties of the situation without reaching the conclusion that to deepen the Canal 85 ft. more as would be necessary for a sea-level canal might involve difficulties and delays beyond calculation.

From the nature of the material it would seem that when the water is in the cut it will aid in holding the walls in place, and the plan which is being followed is to let the banks slide as they will, removing the material with steam shovels as fast as it comes into the cut.

The party were entertained at a reception given by the President of Panama, Señor Arosemena, a genial Panamanian, dark enough in complexion to indicate the presence of Indian blood, democratic to an extreme and proud of the Canal and his country. Nov. 3 being the anniversary of the independence of Panama we had the pleasure of seeing an old-fashioned Fourth of July fireworks celebration of the type which is becoming obsolete at home. The President reviewed the army from the balcony of his residence. This army is nothing more than the Panama police force, consisting of 50 men, quite sufficient for a country which is under the protection of the United States. Here we have an illustration of the practical nature of the Monroe Doctrine when applied to one of the small Central or South American republics. The Government can spend the funds of the state on internal improvements, depending upon the United States to protect them against enemies within and without.

An opera party at the National Theater in the evening was a pleasant diversion. This theater is maintained by the government, the players being brought over from Spain at the government's expense; a nominal fee only is charged for admission.

On Nov. 4 an evening session of the Institute was held at the Tivoli Hotel, Where Dr. Gorgas described the work of sanitation which has been so important a feature of the work on the Isthmus. The Doctor gave a few examples of the conditions that existed on the Canal under the De Lesseps regime. He said that three out of every four Frenchmen who came to build the Canal died of yellow fever or some other disease; that of 24 Sisters of Charity who came there as nurses only two survived; that a French Director General lost through yellow fever every member of his family, consisting of his wife and three children, and he himself became insane.

He described in detail the sanitary regeneration of the city of Panama, which had long had the reputation of being one of the most unhealthy cities in the world. Each residence formerly had a cistern to catch rain water for drinking purposes. The water in these cisterns bred mosquitoes, which transmitted yellow fever and malaria. The yellow fever mosquito is a different mosquito from the malaria mosquito. The yellow fever mosquito is invariably a female. She cannot transmit disease until she herself has taken it, but after a certain period the mosquito becomes infected with yellow fever and transmits it to others. This mosquito is domestic in its nature and does not fly far from its place of birth. Were it otherwise, Dr. Gorgas said, the yellow fever mosquito might almost exterminate the human race.

Dr. Hayes, of the United States Geological Survey, talked on the geology of the Isthmus, and Gardner Williams showed lantern slides of the diamond and gold mines in South Africa.

Saturday, Nov. 5, was a day of play [illegible] excursions to Taboga Island, a beautiful [illegible] in the Pacific Ocean, near the entrance of th[illegible]anal. In the evening the Institute gave a re[illegible] at the Tivoli Hotel with dancing and a su[illegible] This was attended by the English, French a[illegible]her foreign ministers at Panama, by p[illegible]ent Panamanians with their wives and d[illegible]ers, and by the officers of the Canal service [illegible] their families.

On Sunday the hospital at Ancon was [illegible]ited. No one can see this hospital without [illegible]iring its equipment, the skill of those in cha[illegible] of it and the beneficent work it does not [illegible]y for those on the Isthmus but throughout [illegible]ntral and South America. Long journeys a[illegible] made to Ancon Hospital and large sums are [illegible]id to the Government for surgical operati[illegible] and treatment given there.

In the evening Mr. E. W. Parker read [illegible] paper on Coal Mining Machinery, illustrat[illegible] with lantern slides. Mr. Rushmore showed som[illegible] recent electric devices, and Mr. Gardner William[illegible] told the story of Cecil Rhodes and the development of South Africa, showing some splendid views of the country, the inhabitants and the game.

On November 7, the entire day was spent in inspecting the Gatun Dam and locks. Though this is the rainy season there had been little rain while we were at the Pacific end of the Canal. The rainfall at the Pacific end is only half as great as that on the Atlantic end. This was verified when the party reached Gatun, where there was a baptism of rain which fell at the rate of 3.28 inches in 59 minutes. Of the lock work at the Atlantic end, 42% of the concrete has been laid, and 15% of the lock concrete at the Pacific end. The Gatun Dam is about one-third finished. The toe-walls, consisting of dumps of broken rock about a quarter of a mile apart, are plainly in evidence. Between these dumps clay and sand is pumped in. This materials hardens when it settles, and will form an impervious core for the dam. The material is being pumped into the dam at the rate of 550,000 cu. yds. per month. The entire volume of the dam will be 23,000,000 cu. yds.

The figures of cost show that concrete is being laid on the Pacific end at $4.65 per cu. yd., a figure unusually low, but the conditions there are very favorable, the stone being brought from the Ancon quarries close at hand, over favorable grades and the sand comes from the Pacific end. The concrete at the Atlantic end costs about $2 in excess of these figures. In partial explanation of this the statement was made that the work is done in 8-hour shifts on the Pacific end and 12-hour shifts on the Atlantic. These 8-hour shifts effect certain economies in operation. Cantilevers are used on the Pacific end and cable-ways on the Atlantic, and it is claimed that the cantilevers effect economies in transportation of the material. Wood forms are used on the Pacific end and steel forms on the Atlantic. It is questionable whether the steel form has any advantage over the wood. As the steel forms are very expensive, there is no surplus on hand to give elasticity in moving the forms from one place to another, as the forms have to be left in place until the cement is set. At the Atlantic end the stone for the concrete costs $2.40 per yard in the stock pile. Of this $1.10 is amortization of the plant, tugs, etc. This is a heavy amortization charge, due to the fact that the quarries are at Porto Bello, some 25 miles from Gatun, requiring a large equipment of scows and tugs and double handling of the material. At the Pacific end the material is brought down grade from the quarry in cars and is delivered directly to the concrete mixer, hence there is little or no amortization charge and the cost of the stone at the Pacific end is said to be only 80 cts. per cu. yd. in the stock pile. Another handicap of work at the Atlantic end is that the weather is worse, not only in the storms which beset the tugs and scows in going from Porto Bello to Gatun, but in the heavier rainfall. The figures appear to show but little difference in cost of concrete at the two ends when based upon taking the stone and sand from the stock pile and mixing and placing. In other words the difference in cost is chiefly due to the differ-

ence in the cost of materials. Even the cost on the Atlantic end compares favorably with the cost of concrete on the New York Barge Canal, which is said to average $7.34 per cu. yd.

The cost sheets show that rock is being removed on the Canal for about 50 cts. per cu. yd. in the dry. This cost, however, does not include administration expenses, which would bring it up to about 70 cts. The removal of rock under water by the drill scow and by the Lobnitz system is said to cost somewhere between $1 and $2 per cu. yd.; the figures are not yet accurately determined because not enough dredging has been done so far. Both systems appear to have their place on this work, the drill scow being adapted to heavy cutting and the Lobnitz for light work where a depth of only 2 or 3 feet is to be removed. The amount of rock to be excavated under water has been reduced to something like 150,000 cu. yds. by the plans which are being carried out of coffer-damming the work, excavating the soft material over the rock by hydraulic dredges and jacks and then removing the rock in the dry.

To sum up, it is plain that the Canal is being built expeditiously, on wise plans, and with an organization that is well fitted to carry out these plans. Recent floods have deposited hundreds of thousands of yards of gravel at the mouth of the Chagres River, thus contradicting the claims which were made by the sea level advocates, that the Chagres is not a sediment-carrying stream. This material from the Chagres bed is in evidence everywhere, being used in the towns for road building. It consists mainly of pebbles, but with the setting back of the Chagres by the Gatun Lake, that stream will empty into the lake ten miles from the Canal line, so it is not likely that any material of consequence will be carried down to the sailing channel.

The work of excavation is nearly three-quarters done, but no attempt is made to finish the excavation in advance of the lock and dam work on the Atlantic end, the plan being to carry all the work along together from one end of the Isthmus to the other. That the Canal will be finished some time during the year 1914 there appears to be no reason to doubt.

The Hotel Tivoli at Panama is a first-class hostelry, finely located on a hill facing the Pacific. It has beautiful surroundings and is very comfortable, notwithstanding the difficulties in giving food and service satisfactory to those who are accustomed to first class hotels in the North. The food is drawn from the government commissariat. Vegetables are not raised on the Isthmus and chickens are scarce, hence everything is imported. The waiters are easy-going West Indians, some good, some bad and others very bad. A Tivoli waiter put a finger bowl in front of Mrs. William Kelly, with the remark, "Wash your fingers, Miss!" This same waiter was transferred to Gatun when the party was given a luncheon there, and recognizing Mrs. Kelly he apologized for the absence of finger bowls by giving her a soup plate to "wash her fingers in."

We sailed from the Isthmus on Nov. 8 and cheers went up from the pier at our departure. These cheers were taken as a compliment, but it is said that a delegation of Congressmen were also cheered on their departure, and that a man on the dock was heard to exclaim: "The Lord gave and the Lord hath taken away, blessed be the name of the Lord."

On the homeward voyage an election for Governor of New York, resulted in a majority for Mr. Stimson. Captain Krausè assured us that his passengers had never failed to correctly indicate the result of the elections!

Sessions of the Institute were resumed, the subject of discussion being the Panama Canal work. A uniform sentiment was expressed in favor of approval of the plan and execution. This was embodied in a signed statement which was published in Engineering News of Nov. 17.

On Nov. 10 the day was spent at Kingston, Jamaica, where we took lunch at the Myrtle Bank Hotel on the invitation of President Brunton, who received his reward in cheers for "Baby Brunton whose daddy went a'hunting." It was moved, seconded and unanimously adopted, that Brunton be continued as President of the Institute until the completion of the Canal. An enthusiastic member moved as an amendment, that the Day of Judgment be substituted for the Canal. The party was honored by a visit from a German Prince, the nephew of the Emperor, accompanied by an alligator. The Prince was in Kingston Harbor on a German warship, and having shot an alligator he wanted to send it home, so he took advantage of the sailing of the "August Wilhelm."

Sessions of the Institute were continued, a paper being read by Mr. Goodale of Butte on the Utilization of Electric Power. He explained the system being installed there by which electric current at 110,000 volts is carried 132 miles to Butte, where it is to be used to generate compressed air for running 30 hoists, all situated within a radius of 1½ miles, the compressing plant being located in the center of the district. Mr. Watson described the Taylor system of compressing air which is in use at Cobalt and said that they had found that this air contained less oxygen than normal compressed air, the difference being such as to prevent the use of candles in the mines. At times if the air reserve is drawn on rapidly, moisture is carried over.

The last stopping point before reaching New York was Fortune Island, where 38 negroes, known as deckers, were put ashore, these men having been taken on only for the purpose of handling freight. Fortune Island is a narrow strip, about a mile wide and several miles long. It belongs to the British Bahama group and is peopled by negroes. There are only two white men on the Island, the British Governor and the postmaster.

President Taft was on his way to the Canal while we were en route north, hence a wireless was sent into the air as follows:

American Mining Engineers returning from Isthmus congratulate you upon good plan, splendid management and satisfactory condition of work.

To this came the following reply:

Your message received. It is most satisfactory to have the assurance of men who are experts that the great canal construction has been well planned and is being carried on to a successful completion. I thank you for this visit and the courtesy of your kind message. Taft.

To pass a President of the United States with such a party on board was an era in the record of Captain Krausè, who bore on his breast a medal from the old German Emperor for saving a life and the Honor of the Golden Cross from the present Emperor for saving a ship. So when these wireless messages were received this gallant captain slept not at all. Changing his course, he steered his ship landward, and figured the time and place where the Prinz August Wilhelm might meet the two warships bearing the President of the United States. About two dozen passengers kept the captain company, and paced the deck, straining their eyes landward in the pale moonlight, hoping to catch a glimpse of the naval vessels.

All at once those below heard a great noise. Men ran about the decks, the halyards rattled, and at the sound of the Captain's whistle the port side of the ship was ablaze with red, white and blue lights, discharged from each deck and from many port-holes. The wireless was also put in action, sending sputtering notes and lightning flashes at the foremast. It was indeed a sight that "left itself forever on your mind." But the land lubbers who came on deck to see what it was all about failed to recognize a thing but the clear moon and its streak across the water "See it there," said the Captain, "right under the moon."

Time passed, the lights went out, and quiet had been restored, when the watch in the crow's nest called out the news, "two steamers on the starboard quarter." Soon every one could see approaching us the two mammoth warships bearing the President and his party, and the good Captain confessed that he had saluted a coal hulk bearing its load of Pocahontas down to the Isthmus. The Captain was sure that the coal hulk responded to the signals as he saw something going up in the air in the light of the flashes from the "August Wilhelm." Imagination only can picture the exultation on the deck of the coal hulk, and the things that the Captain saw ascending were doubtless chunks of best coal, thrown mastward in acknowledgment and appreciation of the noble salute. The log of no coal hulk ever before recorded such a greeting.

The sessions of the Institute were continued. Mr. Ayres presented his paper, "Conservation of Coal and Its Preparation for Market." President Brunton read a report of the Thirtieth Annual Convention of the American Mining Congress which was held at Los Angeles, Cal., Sept. 26, 1910. Mr. Taylor read a report of the Mining Congress on rules governing the installation of electricity in mines, referring briefly to a report in detail which will be printed in the "Transactions" of the Institute. Dr. Raymond read a letter from Prof. Edw. H. Williams, Jr., of Woodstock, Vt., in regard to the proposed mining laws. The printed report of the Committee on Uniform Mining Laws for the Prevention of Mine Accidents* was presented and discussed by Mr. George H. Warren, Mr. Kirchhoff, Mr. McAuliffe, Mr. Warriner and Mr. Jennings. Mr. Jennings dwelt particularly on the matter of secrecy and said that the true policy of a mining company, like the true policy of any company offering its stock for sale on the market, should be to give the public all information available concerning the mine, the costs included. He said, "If we desire or demand the open shop, we should give an open office. This hushed, under the breath talk about mines only hurts the industry and helps the swindler." Messrs. Goodale, Kelly and Watson also joined in the discussion. Mr. Gardner Williams said that in English countries the regard for law is much greater and the enforcement of law is very much better than in the United States.

On Sunday, Nov. 13, services were held by Dr. Raymond in the morning. Robt. P. Porter, of the editorial staff of the London "Times," addressed the Institute upon South America, and the evening was given up to an enthusiastic celebration of the birthday of Dr. Joseph Struthers, who while not the master of the ship, was surely the master of the trip. To Dr. Struthers, more than to any other one person, belongs the credit for the success of the excursion.

On the 14th, sessions of the Institute were continued. Dr. Raymond read the proposed resolutions expressiing approval of the plan of work of the Panama Canal, which after amendment were unanimously adopted. Prof. Richards addressed the Institute on the Electric Manufacture of Steel, and the President adjourned the meeting with congratulations for an experience which can only be characterized as one continuous carnival of pleasure and interest.

The Triborough Subway in New York City; Statement by Chairman Willcox of the Public Service Commission.

The bids on the principal sections of the Triborough subway in New York City, which were opened on Oct. 27, are now being studied by the engineers of the Public Service Commission, preparatory to submitting them to the Board of Estimate and Apportionment for final approval of the plans and award of the contract. This imminence of the official action which will authorize the Triborough route (see Engineering News, March 10, 1910, p. 288) has brought to a head all of the opposition to that route, particularly that opposition which is backed by the operators of the present subway, the Interborough Rapid Transit Co., which has an alternative scheme of construction that the Public Service Commission has heretofore refused to accept. This opposition has become so pronounced that the chairman of the commission, Mr. W. R. Willcox, has seen fit to give out a public statement of the position of the commission in the matter. This statement, which we reprint below, is a very explicit account of the present stage of the subway developments in New York to-day.

Beginning years ago the question of a Triborough System, that is, of a comprehensive system of rapid transit, was considered and decided upon by the Rapid

*Engineering News, Nov. 10, p. 505.

Transit Commission and the then Board of Estimate and Apportionment and has been adhered to with certain changes since then by this Commission and by successive Boards of Estimate.

If, when the city has once become committed to a comprehensive plan, the work is to be suspended whenever new contracts are about to be let, no rapid transit relief will be secured, but we must go on for another generation with the frightful congestion of population, the overcrowding of tenements and the indecent jamming of our transportation lines which are so evident. The cost of construction, including station finish, of the entire Triborough system as contemplated is $147,500,000. Of this system the Center St. loop, costing $9,800,000, is nearly finished. The six sections of the Fourth Ave. subway, costing $15,000,000, will be finished within 18 months. The Manhattan Bridge portion, costing not less than $25,000,000 is nearly finished. The Williamsburg Bridge, costing almost as much, is already finished. The cost of these bridges does not come within the total cost of the Triborough, for the policy of the city has been not to include cost of bridges as part of rapid transit and not to expect any revenue from bridges. The city is committed to these links of the system. They are admittedly the expensive and less profitable parts. Standing alone they represent stub ends. These subway links, and in large part the bridges, will be useless unless the comprehensive plan of which they are a part—the Triborough system—shall be completed. As single units, they cannot be made to produce adequate income, and no Board of Estimate, Rapid Transit Commission or Public Service Commission ever for a moment labored under the delusion that they would be worth building, if the system of which they are a part should be abandoned. The reason for their construction was that they were links in a chain and a beginning had to be made somewhere.

The fundamental question is not, therefore, whether the city shall now *begin* the Triborough system, but whether having spent $25,000,000, it shall spend a further amount to complete the system. Let no mistake be made. The opposition is *now* so hostile to the construction of the trunk line of the Triborough because it will be profitable and when connected with the Loop and Fourth Ave. subway will make profitable what may not be as profitable without articulation. They require the completion of the other portions of the system. These portions—that is the Lexington Ave., with the two Bronx extensions, Canal St., Broadway-Lafayette and the two South Brooklyn extensions, on $85,000,000 bids received and estimates on the remainder, will cost, including station finish, $123,000,000, as compared with $209,000,000, the cost of construction of those portions as given by certain critics. The location of the bridges was not determined by the Public Service Commission or the Rapid Transit Commission, but a rapid transit system had to be correlated to them. Had there been no Manhattan Bridge it might have been possible to go to the Battery and then to Brooklyn, thus omitting any Canal St. cross-town line.

This is not the time for discussion of the advisability of the Center St. loop or of the Fourth Ave. subway under construction. The Center St. loop was contracted for in 1907, with the approval of the Rapid Transit Commission and the Board of Estimate. The plans and forms of contract of the Fourth Ave. subway had been progressed by the Rapid Transit Commission to the point where, when this Commission came into office, eminent lawyers were of the opinion that the Commission had no discretion but must proceed to the securing and awarding of bids for construction.

Now, as to remaining portions of the Triborough not yet under contract, consisting of Broadway-Lexington, Broadway-Lafayette, and the criticism that the cost would be excessive, let certain comparisons be made.

It is believed in view of the cost of rapid transit lines under contracts heretofore made, that its cost is reasonable. The average cost per mile of track of the municipal rapid transit routes now operated by the Interborough was $734,351. In 1907, the President of the Interborough, in a letter to the Rapid Transit Commission giving the reasons why his company was not a bidder on the routes then proposed, stated that his engineers had found that the increased cost through labor, material, methods of construction, etc., would increase the average cost per mile of track by 100%. Within a few days two directors of the Interborough have stated in a conversation that it would cost double the amount if the Interborough subway were to be built now. In the portions of the Triborough not yet under contract the cost on bids submitted and estimates made will be $1,014,000 per mile of track. In other words, the cost per mile of track of the Triborough is only 30% more than the Interborough and nearly 70% less than what officers and directors believe the Interborough could be reproduced for now.

If comparison be made in the cost of construction of the Triborough with the present subway and not with the Interborough figures when it was reluctant to bid, the 30% increase of the Triborough is not an unreasonable amount having in mind the public requirement that construction must be under cover and not in open trenches; that the cost of labor, including employers' liability, has increased and that the size of the structure has been somewhat increased. The increased size of the bore will allow an increase in the width of the cars of the Triborough over the Interborough of 16%. The multiple stations of the Triborough, together with the methods of connection between express and local tracks will make possible the running of trains in less than 1 min. 30 secs., as compared with 1 min. 48 secs., which is the best that the Interborough is able to do because of the delay at stations. In other words, even if trains of the Triborough maintained a headway no better than 1 min. 30 secs., although it is believed possible to operate them at intervals of 1 min. if manufacturers of brakes and signals are able to perfect such devices still further, there will be an increase in the train headway of 13%. Consequently the Triborough, although its cost will be 30% more, will represent an increase in capacity on a conservative estimate of headway and car capacity of almost an identical per cent. In addition to this increase in train capacity of nearly 30%, the stations will accommodate ten cars, which in itself represents nearly 25% additional capacity over what the Interborough is now doing.

In the Interborough there are 74.18 miles of single track. In the Triborough there are 144 miles of single track and it is laid out in such a way that there are in fact three routes—the north and south one in Manhattan and the Bronx; the Broadway-Lafayette and the Fourth Ave. Each of these will furnish a maximum rush hour traffic of its own. In addition there will be at least three areas of short haul business—from outlying portions of Brooklyn to the center of Brooklyn; from the center of Brooklyn to the center of Manhattan; from points in Manhattan to other points in Manhattan.

Considering the increase in width of cars and reduction of headway, three-way rush hour travel and three centers of short-haul business, the indicated capacity of the Triborough on the same basis of extreme congestion that now exists in the Interborough will be around 3,000,000 passengers per day. The actual traffic that would offer itself after construction is completed can only be judged by experience. Engineers of the Rapid Transit Commission figured in advance that the extreme capacity of the present subway would be around 800,000 passengers per day. Engineers and financiers in considering the matter of bidding on the original contract did not expect that traffic would develop beyond 400,000 passengers a day. The actual traffic has exceeded the estimate of extreme capacity. In 1899 when the present or Interborough subway was contracted for, the surface lines in New York County carried 380,000,000 passengers and the elevated 174,000,000. Fears may then have been felt that the subway would not develop its own traffic, yet in the year ending June 30, 1910, in New York County the surface lines carried 430,000,000, the elevated 293,000,000 and the Interborough subway 269,000,000. With these figures in mind the argument that the Triborough would afford unnecessary capacity inasmuch as it would take most of those who now ride on the elevated and subway falls to the ground. It might just as well have been stated in 1899 that to build a subway to carry 260,000,000 would take away all of the traffic from the elevated and a part of the traction traffic, while the facts show that it has developed not only its own traffic of 269,000,000 and is crowded beyond the point of decency but the surface and elevated lines have increased 33%. The developments in suburban travel on the part of the electrified divisions of the trunk railroads and the average increase in travel in the city, which is nearly 70,000,000 passengers a year, lead to the belief, without here going into further details, that actual traffic offering itself on the Triborough will approach very closely to its capacity.

Some persons have evidently attempted to create the impression that there is a difference between the Board of Estimate and the Commission. As a matter of fact, the Commission, because the Rapid Transit Act requires the approval of the Board of Estimate to every formal step in connection with rapid transit routes, has endeavored consistently to learn the probable attitude of the Board and to govern its action thereby. An examination of the records will show that the Rapid Transit Commission and the Public Service Commission in acting on the various parts of the Triborough system have consistently, since 1906, secured and followed the advice of the Board of Estimate so far as it has been possible to get such advice. In June, 1909, after a full approval of the Triborough system, the Commission endeavored to have the Board indicate in advance its wishes as to what portions of the Triborough system not then under contract it deemed should be first contracted for, and whether the Board considered it advisable to have bids secured for construction, equipment and operation or for construction. The Board relying on the fact that the Rapid Transit Act did not require formal action at that stage of the proceedings, left the matter to the discretion of the Commission. With the coming in of the present Board of Estimate, it appointed a Transit Committee with which the Commission frequently discussed questions involved in these contracts. Later the contracts and specifications were gone over in detail in conferences between a member of that Committee and its engineers and representatives of the Commission and an agreement was reached. The forms were then approved by the Corporation Counsel and bids were invited. So far as the Commission is aware, nothing has been done that is in conflict with the judgment of that committee. As soon as the Commission can complete to its own satisfaction the consideration of these bids with all the detailed items involved, it will advise the Board of Estimate for its action.

Common-School Education and the Development of the Apprentice.*

By J. J. FLATHER,† M. Am. Soc. M. E.

The general introduction of manual training in the schools will not meet the requirements as it is not sufficiently intensive to be vocational. With few exceptions the time devoted to any one subject does not exceed 250 actual hours, and when one considers that it requires from 8,000 to 11,000 hours for a boy to learn a trade and that he may put in 250 hours in four or five weeks, it can be readily seen that the manual training of our schools can have little weight as a preparation for vocational work.

Over 48% of the pupils who enter school drop out before the end of the eighth grade, that is, at from 12 to 14 years of age, and no manufacturer or other employer wants a boy so immature physically and mentally as this.

Undue loyalty to democratic ideals has prevented our school boards from differentiating their courses to any marked degree and the attempt is made to put all pupils through the same general studies. In the commercial and business world we soon discover that all men are not equal. We must also recognize the same conditions in the status of our school children and make provision accordingly. Here in the city of Chicago to-day nearly 50,000 children are "repeaters" who are spending the second, third or fourth year in the same grade, and at a cost in actual oulay, of over $200,000 per year.

Manual training should be taught in all the elementary schools and, at the end of the sixth grade, corresponding to the age of 12 or 13 years, separate courses should be established. The one would be, as at present, arranged for professional and commercial training, as well as the higher technical training leading to and through the high school. The other would have in view the industrial training of the pupil. Bearing in mind the class of boys it is desired to interest and develop, and the object to be attained, practical work should predominate. But during the seventh and eighth grades, that is during the first two years, the training should be general and not specific. In order to keep the boys busy, inasmuch as there would be less need for preparation of studies, it would seem desirable to require that seven hours a day be spent in school, of which time at least four hours should be devoted to practical work under skilled workmen.

Two additional years would follow this industrial-preparatory term and these should be trade-preparatory. The time should be devoted to some one definite trade, to the end that after judicious and intelligent training the boy may enter some industry where he will be given an opportunity, at fair wages under an apprentice instructor, to finish the trade begun in the preparatory trade school. In this school, which a boy enters at 14 or 15 years of age, the time could well be increased to eight hours a day with four hours on Saturday and there seems no good reason why the practical work should not be continued for eleven months of the year.

The amount of time required to finish a trade would be reduced very materially under such a plan, and it is safe to say that the hope of early reward would encourage many a boy to hold out and complete the entire school course instead of quitting as at present. It is not to be expected that all such boys would become skilled artisans, but it must be admitted that the training could well be adapted to prepare all boys who might desire to enter industrial pursuits. By a process of selection and elimination, those best qualified by natural endowment and otherwise, could be trained as all-around men for the trades, while others who did not give such promise of development would be trained for some special work.

It is recognized that no universal system of trade education will be generally applicable to every community; local conditions will suggest and demand modifications, and we should expect in certain localities to find emphasis laid on the teaching of trades required in those industries which predominate in that vicinity.

In working out the course of study for such industrial education it should be constantly borne in mind that some of the boys who enter upon industrial training will reach a time in their lives when they will want to keep on with their studies and enter a technical college. Provision for such boys must be made by a modification of the high school course, with this in view and, if necessary, the college entrance requirements should be changed.

*Abstract of a paper read before the National Foundrymen's Association, Chicago, Ill., Nov. 17, 1910.

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It may seem a contradiction in terms to say that the New York subway situation is up "in the air," but it appears to be as truthful and accurate a statement as can at this time be made. The bids for the Triborough subway have been tabulated by the engineers of the Public Service Commission and that body is reported to be about ready to recommend the award of contracts for the work. The award has to be approved, however, by the Board of Estimate and Apportionment, which is the real governing body of New York City. What the Board of Estimate will do, it would be hazardous to prophesy.

There are two large and vociferous factions, one of them favoring and the other opposing the Triborough project, but alike in that the interest of each in the enterprise is purely selfish. The first of these factions is made up of the real estate interests of Brooklyn and of the Bronx who want the subway built because of the boom it will give to land values in their respective sections. The second of these factions is inspired by the financial interests which control the subway now in operation. They do not want any subway built which might be operated in competition with the lines which they control.

Both of these factions are simply working for their own financial interest. Their counsel is, therefore, a most unsafe guide as to what will be for the best interests of the city as a whole.

And the problem what course should be now adopted to bring about "the greatest good to the largest number" is not by any means a simple problem.

It is entirely correct to state that as a general rule, all the street railway lines of a city should be operated as a single system. Nearly every American city has passed the era of independent rival street railway corporations, and the cases are few now where a city's street railway lines are not owned by a single corporation. No one now argues for competition in the street railway business to protect the public. It is recognized that the carrying of passengers on city street railways is a natural monopoly. The public must be protected in its use of this monopoly by legislatures and courts and commissions.

In accordance with this principle, additions to the subway system of New York City ought to be made as a part of the system already built. Even though built by the city, the lines should be added to and operated as a part of the present subway system.

But circumstances alter cases. There are some very good reasons against the use of New York City's credit to build extensions to the present subway system to be operated by the present Interborough corporation. Whether these ought to be controlling reasons, we cannot now say, but we are certain that if the good corporations and the bad corporations were divided into herds of sheep and goats, the Interborough company would be found wearing long horns and a beard.

In laying out the Triborough system as a route that can be operated independently of the Interborough, the Public Service Commission has undoubtedly acted in accordance with public sentiment. It has also acted with sound business judgment, for unless a line is susceptible of independent operation, the city ought not to build it except by agreement with the Interborough. It would not do for the city to spend millions of dollars building extensions to the Interborough system which could not be operated profitably without it, and then have the Interborough directors calmly dictate the terms on which they would take it over for operation, and if the city didn't accept the terms the line could be idle.

The important questions regarding the Triborough system therefore, is whether it can command a traffic sufficient to make it a paying enterprise if operated independently. Chairman Willcox of the Public Service Commission, in a statement printed in this issue, claims that it can. Strong support is lent to the Triborough enterprise, also, by a public offer to lease the system when completed, made last week by Mr. William McAdoo, head of the Hudson Tunnel system. Mr. McAdoo proposes some changes in the plans for the Triborough lines; but he heartily indorses the position of the Public Service Commission that the Triborough lines can command sufficient traffic to make them very profitable.

It is quite possible that Mr. McAdoo's proposal may be the first step in a revival of competition in New York street railway service. In any event Mr. McAdoo's definite offer to lease the Triborough system when completed is likely to have an important influence upon those members of the Board of Estimate who are trying to find how the city's interests will be best served.

Those who still talk with greater zeal than wisdom of the immense fertilizing values going to waste because so little of the sewage from our municipal sewerage systems is utilized for agricultural purposes may consult with profit a paper read before the Association of Managers of Sewage Disposal Works; abstracted elsewhere in this issue. We particularly commend this paper to the advocates of sewage utilization because it is written by a man attached to agricultural rather than to engineering interests. If one could expect favorable testimony as to sewage utilization in any part of the world, he would certainly look for it from England, where the practice has been not only advocated but actually carried on for several score of years. Sewage farms of all sizes, from a few acres to between 1,000 and 2,000 acres, have been conducted for many years with as much skill and intelligence, and with as favorable labor conditions, as one could look for in any part of the world, and yet Mr. Voelcker sums up the whole matter by stating in effect that the theoretical fertilizing value of sewage disappears in actual practice.

Sewage farming has been tried but little in the United States. The soil and climatic conditions in many portions of this country are far more favorable for sewage farming than are those of England, but two material obstacles in the way of satisfactory results exist. One, which is far less serious than the other, is the relatively high dilution of American, as compared with British, sewage. The other, and almost fatal obstacle, under the conditions which now exist in most American cities, is the high price, short hours and general inefficiency of labor engaged on municipal work.

We have often pointed out the apparently great and favorable opportunities for the use of sewage for irrigation in the arid portions of the Western United States, where every drop of water is of high value for purposes of irrigation. This value far exceeds any possible fertilizing value of the sewage, but the latter is, perhaps, not to be ignored in considering the possibilities of sewage utilization in the West. A considerable number of Western cities have tried to utilize sewage in irrigation on a larger or smaller scale in the past, but so far as we know comparatively little in the way of permanent practices and results have followed these attempts. The chief exception appears to be Pasadena, Cal., which, for a number of years past, has operated a somewhat large sewage farm with results which, on the whole, seem to have been gratifying. Unfortunately, the financial results obtained are not published in such shape as to show just how much of profit or how much of loss there is connected with this enterprise. The indications are very strongly in the direction of loss, provided all proper capital charges are taken into account. These charges, however, appear to be completely overlooked by the city officials of Pasadena. Insofar as the attempt to justify this practice is concerned, the officials seem to base their defense upon the rapid appreciation of the value of the land which has been acquired and is utilized for the sewage farm. This is a very blind and unsatisfactory way of determining the actual financial status of a municipal or other undertaking. Any appreciation in value may be very profitably taken into account by the city, but not merely by lumping it blindly as an offset to capital charges and any deficiencies which may occur between operating expenses and revenue.

It is interesting to note that as far back as 1905, when the Pasadena Sewage Farm was visited by a member of the editorial staff of this journal, considerable trouble seemed to be caused by the clogging of land by deposit of sewage sludge upon its surface. Within the past year or so a septic tank has been installed, apparently to obviate this trouble. How it will work, remains to be seen. Probably no final conclusion can be reached until after a number of years of use of the septic tank have elapsed. From meager data, obtained in 1905, the conclusions seem to be warranted that small septic tank installations in Southern California produced less sludge than ordinarily results from septic tanks, perhaps due to the warm and equable climate there prevailing. It may be, however, that these reports of little sludge accumulation were only such as would be true generally of small institutional installations treating little or nothing but domestic sewage. Even though the Pasadena septic tanks should not occasion much trouble or expense in the way of sludge disposal, their construction and operation will nevertheless add appreciably to the capital charges and operating expenses of the Pasadena Sewage Farm. It is a pity that the city officials of Passadena did not from the start institute a system of accounting which would have shown beyond all question just what could be achieved in the way of sewage farming in a section where sewage has high value for irrigating purposes, regardless of any fertilizing value which it may contain. A great service might have been rendered, not only to the city by giving it reliable figures for its own guidance, but also to the whole arid section of the United States, and perhaps some light might also have been thrown upon the general question of sewage utilization where water is not at a premium for irrigation purposes.

When the promoter of a new invention or a gold mine or a "proposition" of any sort begins to talk in millions and hundreds of millions or to tell how industry is to be "revolutionized," it is well for the conservative investor to stop and consider whither he is being led.

We can recall during the past quarter century

a long, long list of these opportunities for sudden wealth which the public has been earnestly besought to grasp; but we do not recall one solitary one of all the many schemes exploited in this way which ever realized the golden prospects set forth by its promoters. We do, however, recall that very, very many of the people who were beguiled into grasping the alleged opportunity gained wisdom at the expense of burned fingers.

Everybody has heard of a thing being damned through faint praise. An even more effectual way to damn an enterprise—even a good enterprise—is to turn loose upon it an imaginative "publicity man," or a promoter with no reputation to lose and no scruples as to the methods he takes to lose it.

We recall an interview years ago with a civil engineer of advanced years and former good reputation. He had taken out a patent for an invention and had parted with its control to a swindler promoter. This promoter made no attempt to actually develop a business and bring the invention into commercial use. Instead he attempted to sell stock to suckers by advertising in the usual way adopted by fake enterprises and attempted to bolster up the scheme by reciting the inventor's reputation and experience as an engineer and also his membership in a national engineering society.

It became the duty of the Engineering News to expose this fraud upon the public. The engineer whose name was misused in this way told us that he had suffered more misery as a result of his mistake in parting with the control of his patent to a swindler than he had ever felt because of any other error in his whole life. Under the circumstances, moreover, he was practically helpless to protect himself.

There may be exceptions to the rule that a man of honesty and good reputation cannot do business with a swindler without coming out loser in the long run; but if there are such exceptions, we do not now recall them.

Of course not every promoter who talks in millions and billions is a swindler. Many are men of the Col. Sellers' type; others have loose fitting consciences so that it comes easy to them to look at the truth with a "double-hextra magnifying glass of ten-million horsepower," as Sam Weller said. Some of the inventions or other "productions" exploited in this way may have more or less real merit; but it is a pretty safe rule that even a good scheme will be effectually killed as an honest and legitimate business by that kind of exploiting.

We are led to these reflections and reminiscences by the receipt of a circular in which is described a new type of crushing machine, which, we are informed, "will effect enormous economies in all crushing operations and should save many tens of millions of dollars annually in the crushing of over 500 million tons of refractory materials in the United States."

The figures are slightly indefinite, but if we interpret "many" to mean at least ten, a short arithmetical computation shows that the promoter is claiming an average saving of 20 cts. per ton by the use of his crusher over the cost of crushing by other machines. Those of our readers who are familiar with rock crushing on a large scale with modern machinery, as in large mining operations or the reduction of road material or railway ballast, know that the cost of the crushing alone with present standard machines is extremely small. From 7 to 20 cts. per ton might be a fair estimate of the range. Evidently, then, the promoter's new machine must do a good share of its work for considerably less than nothing in order to save these "many tens of millions of dollars" which are claimed.

It is hardly possible that the deforesting of the drainage area of the Seine and its tributaries is responsible for the rising water now threatening Paris and rivaling in height the almost unprecedented flood of last winter. The commission of experts appointed to investigate the early 1910 floods could not find any reasonable evidence of such responsibility in that or in any of the previous floods and did, indeed, find valid enough causes in other physical and meterological conditions. On the other hand this river has often been cited by the opponents of the theory that deforestation encourages floods, with statements to the effect that floods in early days when forests were thick and numerous were greater and of more frequent occurrence than they are to-day, after an extensive denudation of the forested area in the upper Seine. In view of the numerous floods of the past half century culminating in the successive inundations of 1910, this negative style of argument can hardly be cited in the future.

A characteristic example of such citations was that made by Prof. Willis H. Moore in his article on "The Influence of Forests on Climate and on Floods," which was reprinted in Engineering News, March 3, 1910, p. 245. Quoting from an American army officer's collection of French engineers' data, he there shows that the average height of flood water in the half-century periods from 1615 to 1850 dropped from 27.5 to 21.2 meters above low water. Unfortunately, these figures do not go beyond 1850, but after the floods of last January, the French engineering press published the high waters of the last half of the 19th century. From them we find that from 1866 to 1910 there were seven floods of exceptional severity, the average height above low water being 26.3 meters, a half-century average not passed since the first half of the 17th century. Furthermore we have now the record of a flood in the fall of the year, nearly approaching in height the greatest flood in the history of the river, which occurred only ten months previous.

We wish to repeat that this is no evidence of the cause of the flood, but we do wish to emphasize the untrustworthiness of the Seine records either for or against the forest-flood controversy.

In our issue of Nov. 10, 1910, p. 515, we expressed curiosity as to the mathematical method by which the Aero Club officials figured out as 1,355 miles the flight of Messrs. Hawley and Post in the balloon "America II." from St. Louis to northern Quebec, when the great circle arc between the known starting place and the more-or-less indefinite landing place is only about 1,175 miles long. Our curiosity is still unsatisfied but our own mathematical work is now verified by the official computation just reported by the U. S. War Department, in which the Hawley and Post record is given as 1,171 1/3 miles, some 24 miles less than the world's record made by the Count de la Vaulx in 1900, which it was claimed the "America II." had surpassed.

The Success of the Panama Canal Plans.

If the American public needed assurance that the Panama Canal is being built on the right plan and in an efficient manner, it has received that assurance in the remarkable report by the members of the American Institute of Mining Engineers who have just returned from an excursion to the Isthmus. That report was received by us just in time to insert in our last week's issue before going to press; but there was no time to add to it the comment which it deserved.

It is interesting at this time to record the changed attitude of the public toward the Panama canal work. Our readers will remember that all through the early stages of the work the American newspaper press was on the qui vive for sensational news from Panama. There was nothing to feature in big type in the hard heroic work the engineers down there were doing day by day. That was not news; but a choice bit of scandal, or the fulminations of a discharged and disgruntled employee, or the discoveries of a Poultney Bigelow—such information was news of vast importance—and good political ammunition for use against the Administration besides.

So it came about that the American public—including many intelligent men, who ought to have known better than to allow their minds to be influenced by idle newspaper stories—became impressed with the idea that the Panama job was being bungled.

Two years ago this fall the criticism culminated in a perfect chorus of attack. It was started by a mere trifle. There was a [illegible] on one of the toes of the Gatun dam just at the time when the Chagres was in flood. A [illegible] ray newspaper man happened to come along and saw in it material for a profitable "story." The information was telegraphed all over the United States that the Gatun dam foundation had failed!

That started the chorus of critics, barking and snapping and growling. It was like the noise at a dog show, during the night hour, when some trifle may scare a diminutive lap dog and sets him to barking. The whole dog assemblage joins in and barks until one after another tires out and wonders what he is barking for anyway. Finally the chorus ends save that one or two cantankerous brutes will continue after all the others have quieted down. It is really a very close parallel!

As our readers will recall, this baying chorus was at its height two years ago this fall. The noise they made got so on the nerves of the public that President Roosevelt deemed it wise to send a Commission of engineers to the Isthmus along with President-elect Taft to investigate the work and report upon it. The report of this commission was saluted with more or less howling by the canine chorus; but the sensible portion of the public made up its mind that it was wise to accept the judgment of experts who had studied the situation on the ground and who had laid upon them the responsibility for getting things right.

From that time to this the Panama Canal work has been going forward steadily and rapidly, attracting comparatively little public attention—a respite which has been entirely agreeable to the engineers on the Isthmus after the fire of criticism of which they were so long the target.

And now the public, which barely 24 months ago was ready to believe that the Panama work was in the hands of a set of numskulls, is awakening to the fact that things are being done down on the Isthmus in which the nation may well take pride,—things of which any nation in the world would be proud.

The United States has undertaken there the greatest engineering work ever attempted by the human race. It is carrying that work forward under direction of its own engineers, at a marvelously rapid pace. The work is being done from beginning to end without graft or corruption or political favoritism. It is being done with the most just and generous and humane treatment of the working force ever recorded in the annals of great enterprises, and it is being done with an economy which is truly marvelous, when ALL the circumstances are taken into account.

Two years ago—to hark back to ancient history again—the American Institute of Mining Engineers at its New Haven meeting gave publicity to a paper by an inventor who had a patent machine to build a Panama canal with—a machine which would do the work so cheaply that he gravely advised the nation that it would not be worth while to build anything there but a sea level canal, because forsooth his machine could do the work so cheaply!

The inventor's machine is still a-borning (with strong probabilities of a still-birth); and now the Institute of Mining Engineers has made most handsome amends for its blunder of two years ago by undertaking an excursion to Panama and publishing on its return the most sweeping and thorough approval of the Panama plans and the conduct of the work that has been at any time made.

We say the Institute did this, but more accurately stated, the approval of the work was given by the individual members who took part in the excursion to Panama in the form of a testimonial over their signatures. Thereby it has even more weight of authority than any action by the Institute itself could probably have. The names signed to the statement, which we published last week, include a number of engineers who are practically conversant with large

tasks in engineering, who are themselves at the head of great organizations and who are thoroughly competent to pass on such problems as those which have been met and solved at the Isthmus.

While the public has now gotten over its anxieties regarding the Canal work and does not need to be reassured that things are all right there, this handsome tribute by prominent members of the Institute of Mining Engineers is none the less important and valuable. It shows not only that the Panama Canal work is all right but that the feats there accomplished are nothing short of magnificent. It shows that having passed now the stage of letting the workers alone, the public ought now to realize that appreciation is due to the work and the workers.

Allied to the testimonial given by the Mining Engineers is the cordial approval of the work voiced by President Taft upon his departure from the Isthmus on Nov. 17. While this statement has been widely published in the newspaper press and is thereby familiar to most of our readers, we print it below as a matter of record.*

In this issue also, is presented a summary of the Annual Report of the Canal Commission just made public this week. The two features of greatest interest in the report are the marvelously rapid progress which is being made in the concrete work and the figures of unit cost.

It may be remembered that when the present plan of work was adopted, some uncertainty was felt concerning the length of time that might be required to construct the locks. The locks at Gatun, particularly, are a far larger mass of concrete than has ever before been constructed in one place, and there were claims by engineers of high reputation that the time required to construct these locks might be so great as to delay completion of the canal much beyond the time estimated.

It was, of course, a very long time after work was undertaken before the actual laying of concrete could begin. The lock-pits had first to be excavated and all the machinery and plant for preparing and assembling the materials and mixing and laying concrete had to be designed, built, brought to the Isthmus and set up. The laying of concrete at Gatun did not begin until Aug. 20, 1909, and the complete plant was not in full operation and tuned up for rapid work until near the end of the year. Nevertheless, as reported in these pages last week, over 40% of the total concrete in the Gatun locks is now laid.

A word may be said also regarding the records of cost per cubic yard for excavation and for concrete construction given in the report. These records are also given in great detail in tabular form elsewhere in this issue. They deserve and will doubtless receive the careful study of the engineering profession. They are the unit cost records in the largest engineering work ever undertaken.

These unit costs are a definite and final answer to those who, in the days when the plan of the canal was under discussion, adopted extraordinarily low unit costs and urged on the basis of these figures that a sea-level canal should be adopted since the extra excavation cost would not be prohibitory.

On the other hand, to one who knows and can appreciate all the circumstances under which the work on the Isthmus is being carried on, these cost figures are a remarkable testimonial to the efficiency and good business management with which the work has on the whole been conducted. Comparisons are inevitable between these unit costs and similar unit costs on works of large magnitude in the United States; but such comparisons cannot be taken at their face value. We could enumerate a half dozen things in which the work on the Isthmus is under radically different conditions from any work in the United States, and each and every one of these conditions operate to increase the cost of the work. On the other hand there are some compensating conditions which operate in favor of the Panama work compared with some works here at home.

Any comparison of unit costs, therefore, on the Isthmus and here, in order to be fair, must first estimate the effect of all these varying conditions. That is one of the reasons why a visit to the Isthmus and actual study of the operating conditions there is requisite to the formation of a fair estimate of the efficiency with which the work is being conducted. Understanding these circumstances, the significance and importance of the approval given by the members of the American Institute of Mining Engineers is obvious.

As we look back over the history of the projects for a ship canal across the Central American Isthmus and the connection of the United States with it, we have been impressed with the debt the Nation owes to the strong and patriotic men who have safely guided her past many a dangerous mistake and crisis and have made possible the present triumphal progress.

It is not inappropriate at this time that we refer especially to one of these crises, nearly a score of years ago, when Congress seemed to be on the point of committing the Nation to a loan of its credit as a guarantee of the bonds of a private corporation which projected a ship canal across Nicaragua. The scheme was only blocked by a few wise and patriotic statesmen in Congress who urged that before the Nation engaged in such an enterprise, it should at least have the proposition examined by a board of impartial experts.

President Cleveland in appointing that board had the wisdom to select as its members three engineers whose ability was beyond question and who could be trusted to render a report without fear or favor. It is not too much to say that the able, conscientious work done by those engineers saved the United States from one of the greatest blunders in its history that would have forever been a reproach to American engineering.

Of those three engineers, Gen. Wm. Ludlow, one of the finest officers ever on the roster of the Corps of Engineers, gave up his life as a result of the burdens borne in his country's service during and after the Spanish war, in which service he won deserved laurels. Another, Admiral Mordecai T. Endicott, long the distinguished head of the Corps of Naval Civil Engineers, has just been nominated for the Presidency of the American Society of Civil Engineers. The third, Alfred Noble, has just been awarded the John Fritz medal for distinguished work as a Civil Engineer and the formal presentation is to be made on Wednesday evening, Nov. 30.

Not only did Mr. Noble render a great service to his country by his fearless and conscientious work just referred to, but in the later history of the Isthmian Canal enterprise he has been perhaps the most prominent figure among all the able engineers who have striven to guide the Nation toward wise action and to save it from mistake. To perform worthily such tasks as these, to carry them forward conscientiously and steadfastly in the face of scorn and ridicule and criticism, to see the final success of plans rightly conceived, and to be honored by one's professional brethren with the highest laurels within their power to bestow—that indeed is the crowning achievement for a Civil Engineer.

*This is the fifth time I have visited the Isthmus, and I have gone over the whole line and looked into every part of the improvement. It is about twenty-two months since I was last here, and in that time the progress made has been most satisfactory. Indeed, it is remarkable.

The first thing that strikes one is the fact that work is being done apparently on every foot of the fifty miles of canal, and done under an organization of men, plant and materials that operates as economically and effectively as if it were a machine, with Goethals in control of a lever which sets and keeps the whole machine in operation.

When I was here 22 months ago the main question was the confirmation of the judgment of Congress in having adopted a lock-type canal instead of a sea-level. The extent to which the Gatun Dam and the locks have been completed has removed from every impartial observer the slightest doubt of the wisdom of the decision made and the feasibility of the plan adopted. This conclusion is further confirmed and clinched by the difficulty occasioned by slides in the Culebra Cut, which for a canal of an 85-ft. level necessitated only an additional excavation that could readily be taken care of. Any attempt, however, to sink a canal in Culebra to a depth eighty feet below the present proposed level would lengthen the time of construction, weary the patience of the Americans, make the cost almost prohibitory, and leave it an exceedingly doubtful question whether, with the difficulty presented by the Chagres River, such a canal would be possible at all.

The Gatun Dam lock, with the lake already 18 feet, and slowly rising to a level of 85 feet, which will constitute the key to the whole plan of the canal, is so far advanced that, taken with the Culebra Cut and the locks on the Pacific side, a definite picture is given of what the canal is to be which inspires one with eagerness for its completion.

The landslides in Culebra can be easily removed, the further excavation and the widening of the slope where they occur merely adding something to the amount of excavation previously calculated upon and to the cost, but the percentage of both time and cost will be very small and not enough to increase the estimates for the completed canal.

The work is so far advanced that the time has come for the discussion of plans for the management and maintenance of the canal, for the government of Panama is peacefully pursuing its course, and enjoying prosperity and political calm in the republic. The authorities in charge manifest every disposition to assist the United States in the construction of the canal, and to conform to every detail of the obligations imposed by the treaty.

LETTERS TO THE EDITOR.

The Imhoff Sewage Tank.

Sir: Your issue of Oct. 20, 1910, contains (p. 415, col. 3) a brief description of the so-called "Imhoff Tank" as applied to the classification of sewage and the treatment of the sewage sludge. The description says that this tank consists of

two circular tanks, each with a conical-shaped bottom. In the top of each tank is a shallow sub-tank, with a series of openings in its bottom through which sludge passes into the larger tank below and is retained for digestion.

This is, in general, a correct statement, but the use of *two* tanks together does not constitute an essential part of the system. For small installation single tanks are frequently used, while in larger plants the tanks are ordinarily so built that the sewage passes through three tanks one after the other.

The description goes on to say that

The sewage passes through each of the two main tanks, by way of the corresponding subtanks.

This is not true, and I venture to bring the matter to your attention because herein lies one of the essential points of the Imhoff system. The sewage flows through the "sub-tanks" (sedimentation chamber is a better word) one after the other and the sludge which settles out passes through the openings in the bottoms of the chambers down into the "main tanks" or sludge-wells, so-called. These sludge wells have no outlet (except a pipe, opened only at intervals, for removing the sludge) so it is impossible for the sewage to pass through them. This is very important because it prevents the sewage becoming contaminated by the decomposing sludge. The openings in the bottoms of the sedimentation chambers are so designed that gases or particles of decomposing sludge cannot come up through them from the sludge-wells into the sedimentation chambers.

Charles Saville.

Essen, Germany, Nov. 1, 1910.

Formulas for Discharge of Overfall Dams.

Sir: In your issue of Sept. 29, 1910, is an article by Mr. W. F. Martin, Assoc. M. Am. Soc. C. E., on "Discharge Measurements and Formulas for Large Overflow Dams," a very valuable contribution on a subject that is yet enveloped in much uncertainty.

Mr. Martin comes to the conclusion that the discharge over dams can be satisfactorily determined from an equation of the form

$$Q = m\, l\, h^n$$

in which Q and h have the usual significance and "m and n are constants to be determined irrespective of the velocity of approach, or length, shape or condition of crest." By logarithmic plotting of gagings he deduces these constants for four different dams, and obtains equations that are no doubt much more nearly true than the classic Francis formula.

Unfortunately few gagings corresponding to high heads were included in the data Mr. Martin found available and therefore if he or some other engineer equally competent were to make similar investigations covering a wider range of gagings, including higher heads, the results would, of course, be more conclusive.

Properly conducted investigations of the discharge over *submerged dams* would also be very valuable. For the determination of such discharge the writer has used an equation of the form

$$Q = m\, l\, (x\, h)^n$$

in which the nomenclature is as before except that x is a variable whose value depends upon the degree of submergence, but he has not been able to obtain an entirely satisfactory expression for this quantity and would be grateful for information on the subject through the Engineering News or otherwise.

Peter Mogensen.

Spokane, Wash., Nov. 8, 1910.

Computing the Thickness of an Asphalt Pavement from the Material Used.

Sir: Realizing the inaccuracy of determining the thickness of the wearing surface of an asphalt pavement during its construction by gaging it with a broad putty knife or other similar instrument, and being unable to

find any literature relative to this question, I have endeavored to work out a formula as a further check on the work and in order to be able to maintain an average thickness which average would be the specified thickness.

In working out this formula I have figured on a closed binder, and the formula would be in error to the amount of the wearing surface that would be compressed into the voids of the binder. The formula is as follows:

Where
w = Weight of one box of surface mixture.
a = The area covered theoretically in sq. yds. by one box, t inches in thickness.
t = The thickness in inches of compressed surface mixture.
g = The specific gravity of compressed surface mixture.
x = Area covered by one box, t inches thick, after being compressed.
W = The weight of one cu. ft. of water = 62.4 lbs.
n = The cubical contents of box.
$P = \frac{x}{a}$ = Percentage of theoretical area actually covered by compressed surface mixture.

$$P = \frac{w}{g \times W \times n}$$

$$x = a \times P$$

$$a = \frac{n \times \frac{12}{t}}{9}$$

$$\therefore x = \frac{n \times \frac{12}{t} \times P}{9}$$

Example:

$w = 1074$ lbs.
$t = 1\frac{1}{2}$ ins.
$g = 2.16$
$W = 62.4$ lbs.
$n = 9$ cu. ft.

$$a = \frac{n \times \frac{12}{t}}{9} = \frac{9 \times \frac{12}{1\frac{1}{2}}}{9} = 8 \text{ sq. yds.}$$

$$P = \frac{1074}{2.16 \times 62.4 \times 9} = 0.885$$

$\therefore x = 8 \times .885 = 7.08$ sq. yds.

100%—88.5=11.5% lost by compression.

E. B. Hocker.

City Engineer, Guthrie, Okla., Oct. 29.

More Concerning Transgressions of Professional Ethics.

Sir: It seems unfortunate that the natural modesty of Engineering News should have come to the surface just when and where it is liable to be misunderstood by casual readers. In the editorial on "Recent Examples of Unprofessional Conduct," in your issue of Oct. 27, it is related that one of the highest functions of the journal is to maintain the standards and defend the reputation of the engineering profession.

Based upon an acquaintance of many years, the writer would have said, off hand, that the News endeavored to *improve* the standards and the reputation of the profession. "Maintain" is not a progressive word and "defend"! By associating that word with the reputation of the profession, made up as the reputation is of the accomplishments and undertakings of all members, the News turns aside from its true course and practice to help the wrong-doers, even those referred to in the editorial.

However, it is not the plain violations that are of greatest interest. Without a line of comment, the editorial in question develops a situation that should have had a whole paragraph of comment in the editor's best form.

A prominent engineer secures the selection for a certain piece of work of an engineering firm of National reputation and presumably very competent to design work of the kind desired. The plans are made and presented. A comparatively unknown engineer criticises and misrepresents them, leads the authorities to reject them and to adopt his own plans! Now what has Engineering News to say as to the professional duty of the prominent engineer aforesaid and of the firm of National reputation? Should they remain quiet? This installation of a wretched sewer system is of great importance to a city. Should the profession keep its wisdom inactive in the presence of great foolishness?

(Signed) Q.

Indianapolis, Nov. 14.

[We may say for the information of our correspondent that "the prominent engineer aforesaid" did perform his duty by submitting the whole records and correspondence in connection with the case to the Editors of Engineering News. As to what the duty was of the engineers who made the plans and who were libeled by one of the bidders in the manner related, they might perhaps have brought suit for damages against the party who attacked their reputation. But inevitably their action would be misconstrued by the general public. It would be said they were resorting to the courts to defeat a competitor. Further, there would have been great expense and annoyance to them in bringing such a suit and no resulting satisfaction or recompense. You can't draw blood from a turnip, and it is often better to suffer wrong in silence than to appeal to the courts for redress.—Ed.]

More Concerning an Incorrect Reference to Engineering News in a Stock-Selling Circular.

Sir: Having noticed the reference, in your issue of Nov. 10, to some advertising of stock of the Terry, Tench & Proctor Tunneling Machine Co., calling attention to a certain article which appeared in the "Engineering Record" but which was credited in the aforesaid advertising matter to Engineering News, we desire to present clearly our connection with the above named tunneling machine company.

In the first place, both Mr. Terry and Mr. Tench are stockholders and officers of the company and as such made a contract with the Catlin & Powell Co. to sell them a certain number of shares of its stock at a price agreed upon under certain conditions. Catlin & Powell, in the course of time, arranged with Mr. Holmes to sell a part of this stock and Mr. Holmes started out advertising in a way which was very objectionable to us and made statements which would never have been made had the proofs been submitted to us, and to which we strongly objected, but we did not have the opportunity of passing upon them. At the time, however, we insisted that no further advertising should be sent out unless it was first submitted to us and approved.

We feel that our tunneling machine is a wonderful tool and does not require any such style of advertising as Mr. Holmes used.

Terry & Tench Co.,
per Frederick Tench,
Vice-President and Treasurer.

Lexington Ave. and 131st St., New York City, Nov. 18, 1910.

[The first Terry, Tench & Proctor tunneling machine was described in Eng. News, Nov. 19, 1908, p. 556. A second machine has now been nearly completed, we are informed, and is being tested.—Ed.]

Projected Railway Construction in New South Wales.

Sir: In your issue of Sept. 29, 1910, p. 338, there is an article under the above heading, commenting on one in the London "Times" of Aug. 27. The latter criticised the centralization of the outlet of the railways of New South Wales, at Sydney, due, as it alleged, to the influence of that city. I note with satisfaction that you think that there may be something to be said on the other side of the question.

That there is something, I may make clear from the following: I do not desire to comment on the general question, but only to show that there is a flaw in one of the arguments of "The Times" whose faith in its own conclusions is, as we shall presently see, sufficient even to remove mountains.

Its article is accompanied by a map in which the only mountains shown are an imaginary range in a roughly semi-circular form close to, and, with the sea, entirely surrounding Sydney, so indicated in order to support its argument that, in spite of the difficulties of construction and the heavy grading of the approach to the capital, Sydney influence forced all the lines to converge there, passing over mountains which, according to the map, existed nowhere else, and neglected other ports the access to which had no similar obstruction. Now, any ordinary map of New South Wales indicating mountains will show that "The Times" topography is all wrong. The coast district is undulating throughout, and is backed by the continuous barren coast range 3,000 to over 4,000 ft. high, more or less parallel to the seashore, from 50 to 100 miles from it, and extending the whole length north to south of the state. Moreover, in my recent capacity of Principal Assistant Engineer for Railways to the N. S. W. Government, I know the whole country, having supervised practically all the various railway surveys which have been made connecting the interior with the several coast ports. I am, therefore, enabled to say with authority that the approaches from the interior to the ports other than Sydney, entail quite as difficult work and heavy grading as those converging on the capital.

Yours faithfully,
C. O. Burge, M. Inst. C. E.

24 Park Road, Chiswick, London, Nov. 5, 1910.

The Annual Convention of the National Municipal League.

The sixteenth annual convention of the National Municipal League was held at Buffalo, N. Y., Nov. 14 to 17. The main topics considered were franchises for public-service corporations, city finances and statistics, grafting and the commission plan of government.

The National Municipal League, it may be explained, is devoted to municipal reform in its broader constructive aspects, as related to measures rather than particular men. It now has a membership of more than two thousand, having made notable increases during the past few years. For some seven years past it has been under the presidency of the Hon. Charles J. Bonaparte, a member of the cabinet of Ex-President Roosevelt. At the convention just closed, Mr. Bonaparte was succeeded by the Hon. Wm. Dudley Faulke, of Richmond, Ind., formerly U. S. Civil Service Commissioner. The efficient secretary of the League, Mr. Clinton Rogers Woodruff, of Philadelphia, was continued in office for another year.

Conservation, Patriotism and Efficient Service in Municipal Affairs.

At the opening session, Mr. Faulke made an address on Conservation and Mr. Bonaparte one on Patriotism. Later on, Secretary Woodruff presented his annual review of municipal progress. Mr. Faulke laid stress on the fact that many a city and town is the possessor of resources which if under private ownership, would produce large revenues. He urged that these resources be conserved and made to yield a revenue, and that the principle of conservation also be applied to natural beauties, to human life, and to things of the intellect and spirit. He remarked that although some cold-blooded manufacturers act on the principle that the best policy is to get the inanimate machine, and then scrap both alike, the city cannot afford to scrap human beings when they are to become a public charge. Particular stress was laid upon the possibility of paying all city taxes from the unearned increment of real estate and franchise values. Attention was called to European cities which pay a large part or all their expenses from revenues from commercial lands, particularly forested lands.

Mr. Bonaparte's address showed that love of country or state or city is the governing motive in effective public service rather than pecuniary reward.

Mr. Woodruff's annual review of municipal progress centered around "The New Municipal Idea," which is efficient service for the good of the city rather than benefits for party or individual. He reviewed at length and favorably Mayor Gaynor's administration of New York City and Borough President McAneny's reforms in Manhattan Borough. A feature of the latter has been the employment of numerous engineers, in both major and minor positions, in place of political hacks. Mr. Woodruff also outlined the remarkable progress of the so-called commission plan of city government, and dwelt at some length on tax reform. In general, American cities have no freedom in tax matters, the state dominating as to methods of assessment. In several Canadian provinces the municipalities are being given large latitude in local taxation.

The Municipal Franchise Question.

A committee report and a number of papers were presented on public-service corporation franchises in theory and practice. The committee report was submitted by Mr. Robert Treat Paine, of Boston. The committee was created during the year to review the work on franchises already done by the League and to suggest future work. Mr. Paine reported that in the opinion of the committee the Municipal Program (model city charter of the League) needed revision in its franchise sections. A referendum on franchise grants is needed and so short a franchise life as 21 years is not necessarily ideal. It is questionable whether percentages of gross receipts paid into the city treasury should be used for general city purposes. Public

regulation of franchise companies is needed. Finally, the committee suggested the formation of a larger committee and that a whole session be given to franchise matters at the next meeting of the League. (Provision for the virtual continuation of the committee has been made.)

Separate papers on the franchise tangles in various cities were presented, as follows: "Boston Gas Settlement" (really on the sliding-scale method of charges, with particular reference to Boston gas), by Edgar M. Wrightington, Secretary Boston Consolidated Gas Co.; "Minneapolis Settlement," by Stiles P. Jones, dealing with electric and gas franchises; "Kansas City Settlement," by J. W. S. Peters, dealing with the recent defeat on popular referendum of a 25-year extension of a street railway franchise which still had 16 years to run (see Eng. News, Dec. 30, 1909, p. 729), and "The Detroit Street Railway Situation," by Paul Leake, which detailed at length a proposed settlement which recently failed of being submitted to popular vote. The author of this paper seriously questioned the wisdom of municipal ownership. In one of the settlements at Minneapolis, it may be added, an 85-ct. gas rate was secured, and also an 8-hr. day for the employees of the gas company. A notable feature of the Minneapolis conflict was the repeated re-election of Mayor Haynes, but with previous heavy majorities reduced to only 34 plurality in a vote of 40,000, at the recent election, due to the sudden development of a socialist or out-and-out municipal ownership vote.

Under the title "Is a Rational Basis Possible for Telephone Rates," Prof. Dugald C. Jackson, of Boston, reviewed some of the features of the recent work done by himself and the Massachusetts Highway Commission on the telephone rate question as applied to the Boston Metropolitan District (see Eng. News, Oct. 20, 1910, for a lengthy consideration of this matter, with editorial discussion). Prof. Jackson pointed out that other franchise companies sell commodities, but the telephone companies sell service, which presents a problem of greater complexity, particularly since the cost of telephone service increases instead of diminishes with the volume of business done. Nevertheless, he believed a rational basis of rates possible, by grouping the subscribers and by so arranging one group that the cost of service to it will not be borne in part by the subscribers of other groups—as was the case before the recent adjustment of telephone rates in the Boston district. The ideal plan is to make each subscriber pay according to the quantity of service rendered to him and to fit the quality of the service to the needs of each subscriber.

Prof. Jackson urged that the interest and depreciation charges of public-service corporations is a higher percentage of capital outlay than in ordinary commercial business, because the gross income of a franchise company is but a fraction of its capital, instead of being a multiple, as in the case of ordinary commercial companies.

Taking as his title, "Elements of a Constructive Franchise Policy," Mr. Delos F. Wilcox, of New York City, first briefly reviewed the history of street railway franchises in New York and then presented an outline of a constructive franchise policy, again dealing with street railways, as a matter of simplicity. The latter portion of this paper will be given in one of our future issues.

City Budgets, Finances and Statistics.

A whole session was devoted to city finances, budgets and statistics, under the chairmanship of Mr. L. G. Powers, Bureau of the Census. The first paper at this session was by Mr. Wm. F. Willoughby, Assistant Director of the Census, and was on "The Correlation of Financial and Physical Statistics of Cities." Financial statistics should be correlated with physcial and operating statistics so as to give unit costs of service. Beginning with the figures for the year 1909 the census statistics of cities will be presented in two separate reports, one financial and the other one dealing with physical statistics and unit costs. The latter must be in great detail and technical to be of value, and will be divided into five groups, one of which will be covered each year, thus taking five years to cover the whole field.

A departure in the work of the League was suggested by Mr. Willoughby, who asked whether that the League, having done much valuable work in political organization and government, might not now address itself to administrative reforms. The League might lead the way in consolidating and correlating the efforts of various other societies, as well as city and other governmental agencies, to improve city administrative measures. To this end perhaps a managing committee or council might be formed with representatives from societies and cities. By this means one city department after another might be taken up and its methods, accounts, statistics and forms be gone into in detail. The work would require years of time and would be difficult and costly. As to meeting the expense, the experience of the various private, voluntary bureaus of municipal research gives reason to hope that the necessary funds might be raised without difficulty.

In the discussion which followed Mr. Willoughby's paper, Mr. M. N. Baker, of the editorial staff of Engineering News, laid emphasis on the fact that financial statistics of cities are of comparatively little value unless accompanied by physical statistics, and that attempts to combine the two so as to show unit costs are misleading unless quality as well as quantity of municipal service is taken into account. On motion, the suggestions of Mr. Willoughby, were commended to the attention of the Executive Committee of the League, which, it is understood, will soon appoint a committee to report on the subject.

In a paper on "Budgets and Balance Sheets," Mr. Harvey S. Chase, of Boston forcibly presented the need of revenue or income and outgo accounting; not to show profit or loss, but to reveal, month by month, the actual surplus or deficiency existing in the city treasury. Under the almost universal system of municipal accounting now prevalent many cities are running far behind without knowing it, and are issuing long-term bonds to meet current expenditures. The city of Boston, now has three or four outstanding bond issues for paving and repaving the very same streets, owing to the fact that the life of the pavements has been far shorter than that of the bonds.

Mr. Chas. F. Gettemy, Chief of the Massachusetts Bureau of Statistics, read a paper outlining some features of his work on municipal statistics. Of the dozen states now collecting and publishing city statistics some, like Ohio, have state audit and control of municipal accounts, but Massachusetts merely collects statistics on a standard schedule. The last legislature, however, authorized the Bureau of Statitics to audit and to standardize accounts of cities, on formal invitation from the city authorities. Great difficulty has been found in attempting to compile comparable statistics from 354 cities and towns the accounts of which are kept on different plans. The Bureau is attempting to galvanize bookkeeper's figures into life and meaning.

Commission Government to Date.

A valuable review of the progress, principles and practice of the commission plan of city government was presented by Mr. Ernest S. Bradford at the round-table luncheon on Thursday, and was followed by a lively discussion extending through the whole afternoon. The commission plan, which vests all legislative and executive municipal powers in a council of five men, and generally provides for election-at-large, the iniative, referendum and recall, publicity in all things and various other more or less radical innovations or new combinations of old features of city government, had been adopted by ninety cities on Nov. 1, 1910, as against about fifty only a year ago (see Eng. News, May 26, 1910, for a list of 68 cities, which had adopted the commission plan to that date).

In 46 of 80 cities for which information was available, the commission or council consists of five members; in 27 (small) places the number is 3; in four cities it is four, and in three cities it is 6, 7 and 9, respectively, the last being High Point, N. C. A tabular list was presented, showing the year each of 90 cities come under the commission plan, and whether through a general state law or special charter.

Mr. Bradford gave orally a summary of his impressions of how the plan has worked in a considerable number of cities visited by him, in which he first interviewed representative private citizens and then public officials. His conclusions were very favorable to the plan.

A large part of the discussion on this paper was virtually a debate by citizens of Rochester on the proposed adoption of the plan by that city, or a referendum vote on the plan if ever the legislature will allow the city to vote on a charter which has already been adopted. The general principle has already been heavily indorsed at the polls under what is known as the Public Opinion Law, which permits an expression of opinion on proposed public measures. In so far as the discussion was not local in character it consisted chiefly in the presentation of familiar arguments pro and con, generally put in a very forcible manner, as will appear from the proceedings of the convention.

Miscellaneous Topics.

A variety of other phases of municipal government and administration were brought before the convention by means of formal papers, committee reports and informal discussion at the "round-table luncheons" held each day, and at the banquet on Wednesday evening. Among these bare mention may be made of nomination reform; an extended conference with many addresses on school extension, or the wider utilization of school buildings and facilities for the benefit of the whole community; the police and the liquor problems, corrupt election practices, grafting and civil-service laws, and "The Unearned Increment in Municipalities," including the assesment-for-benefit principles to the payment for rapid-transit subway extensions. A few other of these miscellaneous topics may be considered briefly.

MUNICIPAL LIBRARIES.—A report from a Committee on Municipal Reference Libraries was presented by Mr. Horace E. Flock, Reference Librarian, Baltimore, Md. Municipal reference libraries were established in Milwaukee early in 1907 and in Baltimore later in the same year; in Kansas City in 1910; and one is now under consideration in St. Louis. The committee favors the establishing of such libraries in all large cities, generally in charge of the public library, but located preferably in the city hall. While primarily for city officials, such libraries should be open to the general public. Of course they should be in charge of specialists, chosen for merit.

A paper on "The Library as a Civic Factor" was read by Mr. Samuel H. Rauch, Public Librarian, Grand Rapids, Mich. The author showed how a library can be an educative force in various civic directions.

CITY AND STATE BOARDS OF HEALTH AND THE PROPOSED FEDERAL DEPARTMENT OF HEALTH.—As Chairman of the League's Committee on Municipal Health and Sanitation, Mr. M. N. Baker, of the editorial staff of this journal read a short paper in which he urged that for the present, at least, the most important and effective work of health boards is directed against the spread of communicable diseases; that such work is primarily local, but should be under state supervision for the sake of efficiency, and undertaken by the state where municipal efforts would overlap or conflict or where municipal resources are inadequate. The proposed Federal department of health was favored, but with general, although not exclusive, limitations to interstate fields, such as the protection of interstate water and milk supplies. The paper is printed elsewhere in this issue.

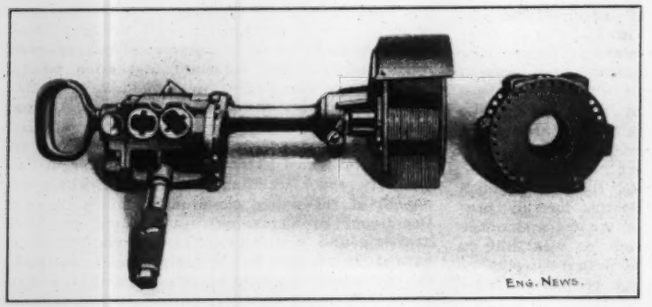
A TOTAL OF 683 GRADE CROSSINGS have been eliminated by the Pennsylvania R. R. Co. on its lines east of Pittsburg and Erie since Jan. 1, 1900, including the grade crossings now being eliminated by the new line through the city of Bristol, Pa.

A Rotary Cleaner for Removing Scale and Rust from Structural Steel.

The removal of rust and scale from structural shapes and plates before fabricating is an expensive and time-consuming process by the usual methods. Hand scrapers, wire brushes and the sand blast are the appliances in ordinary use for this purpose. The tool shown in the accompanying half-tone was originally devised by the Brown Hoisting Machinery Co., of Cleveland, Ohio, for its own use.

The illustration shows the tool mounted ready for use in place of the grinding wheel on a high speed pneumatic grinder. It could, of course, be used equally well on an electrical grinder. At the right of the picture, the cleaner is shown separately. It consists of two circular metal plates about six inches in diameter, mounted on the opposite ends of a hub two or three inches in diameter and about three inches long. The two disks are connected at their peripheries by six equally spaced pins mounted at each end in holes in the disks.

The pins carry the cleaning blades, which are thin steel plates about 2 × 1½ ins. and slightly rounded at the ends. The pins pass through slots in the blades, which are thus free to move a short distance in the direction of their length. Fifteen or twenty blades are mounted side by side on each pin. They are kept a fraction of an inch apart by a slightly raised boss around the slot in each disk and are not crowded together tightly enough to interfere with the motion just mentioned in the direction of their length.



ROTARY CLEANER FOR STRUCTURAL STEEL.

When the cleaner is mounted on the grinder spindle and rotated at high speed, centrifugal force carries the blades out radially from the hub to the limit of motion permitted by their slots. In use the revolving cleaner is held near enough to the work, so that the outer extremities of the blades flick its surface. The play of the blades in the slots removes all possibility of jarring the machine unless the tool is brought much too close to the work. A semi-cylindrical shield, clamped to the spindle frame, covers the upper half of the cleaner to protect the operator.

This tool was used by the Brown Hoisting Machinery Co., which is now putting it on the market, for some time in its own store yard, where structural material is unloaded and cut to size before being sent to the shop. It is claimed that the new cleaner was found superior to a number of devices tried, including practically all those in general use, in every way—less expensive, more rapid and convenient and more effective. Its effectiveness is attributed to the chipping action of the blades. Although the tool has apparently been tested only on structural steel, it should give comparable results in other similar work, such as cleaning castings, surfacing stones and removing barnacles from boats.

THE LARGEST GYRATORY ROCK CRUSHER ever built, according to the Allis-Chalmers Co., of Milwaukee, Wis., is the one recently completed by that company to be installed in the plant of the Biwabik Co. at Biwabik, Minn. It stands 28 ft. high and weighs 500,000 lbs. The two receiving openings are each 48 ins. × 108 ins. and will take pieces of rocks weighing ten tons. The crusher will replace one which has been in practically continuous service since 1901 and will be used to crush iron ore mined on the open pit system.

Annual Convention of the National Society for the Promotion of Industrial Education.

The fourth annual convention of the National Society for the Promotion of Industrial Education was held in Boston, Nov. 17, 18 and 19. Six sessions were held for the discussion of papers on the several aspects of training future workers in American industries. On the evening of the first day's sessions the Boston Chamber of Commerce tendered a banquet to the Society at which educators, local public officials, manufacturers and representatives of labor organizations in different parts of the country were present. Ex-Governor Curtis Guild was toastmaster, and the speakers included Mr. F. A. Delano, President of the Wabash R. R., Chicago; Mr. F. P. Fish, Chairman of the Massachusetts Board of Education; Mr. C. H. Winslow, American Federation of Labor, Washington, D. C.; Mr. C. P. Neill, U. S. Commissioner of Labor, Washington, D. C.; Governor-elect E. N. Foss, of the B. F. Sturtevant Co., Boston.

The first day's sessions were given over to a discussion of problems effecting girls and women in trades and stores. The second day's sessions followed the general subject of apprenticeship schools of corporations and public industrial schools.

Mr. M. W. Alexander, of the General Electric Co., Lynn, Mass, in opening the session traced the history of apprenticeship systems from the old guilds which made membership dependent on a completed apprentice course and on the performance of a piece of skilled work as a successful proof of completion of apprenticeship. The general introduction of labor-saving machinery and of special processes in the middle of the last century brought a revolution to American industrial life which tended to eliminate the apprenticeship system which had previously existed. Under the new conditions, there seemed to the manufacturers no great need for all-around mechanics, and consequently the efforts for general apprentice training relaxed. That this view was fallacious was later shown by the serious problem which has been met in the last 20 years. The sufficient supply of all-around skilled mechanics to guide and instruct those having knowledge of a single process only, could not be found. There were few to build the complicated machinery which specialization had brought forth and to keep it in good order and repair, and to develop the minor leadership on which expanding industries had to depend. It was stated that manufacturers had relinquished their responsibility for the training of mechanics all the more readily because the public school systems at that time began to interest themselves in manual training. These manufacturers expected to receive at once, as the result of these sources, ready-trained recruits where they should have looked only for beginners. This produced an industrial situation where the supply of skilled labor proved entirely inadequate to the demand, and prevented the American industries in general from obtaining full effectiveness and handicapped their logical expansion. Within the last decade, however, the rejuvenation of apprenticeship ideas as the fundamental idea in trade training has been made. Many apprenticeship systems, developed on broad, well-conceived lines, are to-day contributing greatly toward the needed supply of skilled, intelligent, all-around workmen, and the many more contemplated in time will relieve the trouble. Mr. Alexander held that all manufacturers should welcome this phase of industrial education, but should be ready to protest if it seems to tend toward narrowness.

The work of the Westinghouse Electric & Mfg. Co. with its apprentices was described by Mr. Tracy Lyon, of that company. It was stated that a certain amount of theoretical instruction was given during working hours. The apprentices are in the class-room four hours each week during the entire year, where they receive instruction in mechanical drawing and shop arithmetic. The aim is to give the boys manual skill, together with essential knowledge of drawing and arithmetic. The apprentice is first taught the use of a standard machine tool in the apprentice department, and is then sent into the shops to gain experience in the operation of this particular tool. Later he is brought back to the apprentice department, where the instruction is repeated with some other tool, and he is again sent into the shop to acquire skill in operating. In case, however, a boy seems capable of attaining skill in the operation of but a single tool, he is kept to it to his greatest ability in that single line and he becomes then a special operator. Those who wish to broaden their studies may take courses in the Casino Technical Night-School, which is supported in part by the company. Many of the instructors in this school are connected with the engineering department of the company. The company attempts to avoid time conflicts of the apprentice work and night-school work, so that the boys may have every opportunity to advance.

Mr. F. W. Thomas, Supervisor of Apprentices, Atchison, Topeka & Santa Fe Ry., outlined the development of that company's system. It was described as originating when the road was in great need of skilled mechanics, for which definite purpose it was started. The instruction given is theoretical and practical. Each shop of the company has a building set aside for the apprentice school-room, and here the boys are required to spend two hours a day on two days of each week. Here is taught free-hand and mechanical drawing, shop arithmetic, the simplest elements of mechanics and such geography and history as relates to the railroad. The instruction is entirely individual so that each boy may go ahead with his studies as fast as his ability will permit. No text-books are used, but standard lesson-sheets, prepared in the office of the Supervisor of Apprentices, are given to each school. All drawing lessons and problem sheets are taken from the railroad's apparatus. The apprentices are required to work in the shop, like journeymen mechanics, but they are given first-class skilled workmen as instructors, one instructor having 25 or 30 boys to whom he devotes his entire time. At the smaller shops, where there are only a half dozen boys, a traveling instructor spends his time between two or more places and serves as both shop and school instructor. These boys in the smaller shops are transferred to the larger shop for the last year of their course. This railroad spends from $35,000 to $40,000 a year in training these apprentices, but it is found that the boys who have been trained have accomplished enough more work to represent the cost of instruction. Apprentices are paid wages that enable them to live well, that is, to have good food and comfortable and sightly clothing.

Mr. G. C. Cotton, of the Solvay Process Co., Syracuse, N. Y., described a school for training mechanics needed by a concern manufacturing chemicals. The plan adopted by that company is that of having the boys spend alternate weeks in the shop and in the school. The time in the shop follows the regular shop schedule, and the school hours are from 8 a. m. to 3 p. m., with a noon recess. The apprentices are paid for time spent in both shop and school, which makes it possible to secure boys who have to depend entirely on themselves for support. The plan is worked in much the same way as the so-called "cooperative courses," two boys working as partners, the one being in the shop when the other is in the school. On Saturday the one who has been spending the week in school prepares himself to take up the work which his partner has been doing in the shop for the same week. Each Monday morning in the school the boy is required to make a written report of his work during the week past in the shop for criticism by the instructor. The shop instruction is in machine work, plumbing, piping, tinsmithing, blacksmithing, boiler making, bench work, dismantling, construction and rigging. The school topics comprise English, mathematics, drawing, materials of construction, shop equip-

ment, shop systems, observation trips and current affairs.

A paper by Mr. W. B. Hunter, Director of the Industrial Department, Fitchburg (Mass.) High School, described the cooperative industrial course of this high school. The boys go to school one-half of the school period of 20 weeks and work in the shops of some manufacturer 30 weeks in each year. The aim is to make the school course practical, giving such subjects as are believed to be of value to the apprentice in his occupation and to him as a citizen. A two months' trial period in the shop during July and August is provided before the first year of shop work to give the applicant an opportunity to find his suitability for a certain trade. He is paid 10 cts. an hour for the first year of his work in the shop, 11 cts. during the second and 12½ cts. during the third year, making a total of $552.75 for his three years' earnings. The course provided extends for four years, but the first year is spent entirely in school. The manufacturers take the boys in pairs so that by alternating they have one of the pair at work at all times, after the approved plan of "cooperative" schemes. Every Saturday at 11 a. m. the apprentice who has been in school for a week goes to the shop and learns how to take up the work which his partner has been doing in that week, so that he himself may take up the shop work without delay on the following Monday.

Mr. A. L. Safford, Superintendent of Schools, Chelsea, Mass., described an industrial school in Beverly, where about one-half of the persons employed between the ages of 14 and 21 were employed by a single concern—the United Shoe Machinery Co. This company formerly had no apprenticeship system by which their employees might learn the machinist trade. The result was that when a new man was employed he was made a special machine operator, his knowledge being confined to one process in which he remained so long as he was employed. The school was opened in August, 1909, to correct this condition. In the factory of this company a department has been fully equipped for the exclusive use of the school, and here the pupils manufacture machine parts under the direction of inspectors. If the product is up to commercial standard, it goes into the regular factory stock. In the high-school building a laboratory has been fitted for the exclusive use of this school. The course of study has not been definitely formulated at this early period, but it is expected that two years will be given to general instruction in a machinist's work, to be followed by one or two years of specialization. The pupil receives in wages one-half the regular piece work price for all products which pass inspection.

In the discussion of these papers, Mr. G. M. Bassford, Assistant to the President of the American Locomotive Co., stated his belief that apprenticeship offered the only method for thoroughly preparing recruits in the mechanical trades. Modern conditions, he held, made necessary a different kind of apprenticeship from the old type by which the boys learned only what the journeymen with whom they were working were willing to teach. The new type must provide definite and systematic instruction by competent instructors who make this their first duty. Along with this manual training, the boys should be taught the fundamental principles underlying the processes which they perform.

Mr. S. F. Hubbard, Superintendent of the North End Union of Boston, described a school of printing which had been in operation eleven years, under the auspices of the North End Union and supported by master printers. This school does not turn out a full-fledged printer, but furnishes a boy with a fundamental knowledge of the trade. Speed, facility and general development were to be acquired in subsequent years of actual shop apprenticeship. He had found two principles to be fundamental in the successful administration of a school of this character: (1) an apprenticeship agreement between the employer and the apprentice must be inherent in any trade-school system; (2) a trade school should have whatever help it can get from outside sources, but its administration must be dominated by representative men in the trade itself.

Mr. Henry Abrahams, Secretary of the Boston Central Labor Union, gave his reasons for favoring trade schools. In brief, his idea was that as children of the laboring people left school at about the age of 14, they drifted into trades for which they might or might not be suited. A boy of that age, out of school, in order to add to the income of the family, accepted the first job that was tendered. If he happened to get into a machine-shop he became a machinist; if he happened to stop at a barber-shop he became a barber, and nothing but chance determined which.

Mr. F. B. Dyer, Superintendent of Schools, Cincinnati, Ohio, described the continuation school established there in 1909. This is designed for the intellectual improvement of boys already apprentices, and is not for teaching trades. The school board provides school quarters and teachers, and the manufacturers release the apprentices one-half day each week and pay them if they attend school. The course of study outlined includes blue-print reading, free-hand drawing, shop science, applied mathematics, civics, industrial geography, history, reading, etc. Night sessions are held for adult workers, and on Friday nights shop foremen can meet here for discussion of their work. It was stated that the added interest and intelligence of the apprentices more than compensated the manufacturers for their small loss of time.

Mr. S. D. Brooks, Superintendent of Schools of Boston, and Mr. C. A. Prosser, Deputy Commission of Education of Massachusetts, described the evening schools of Boston and the state, intended to supplement the shop training of employees.

At an evening session of this second day, Dr. Georg Kerschensteiner, Superintendent of Schools, Munich, Bavaria, described the "continuation" schools of that city. A system of 52 industrial continuation schools has been organized. Attendance is compulsory for boys who are at work until their 18th year. For every branch of work to be found in Munich in which as many as 20 applications for instruction are made, instruction is provided at public expense. For one entire day or for two half days in each week the employers are required by law to release the apprentices that they may attend the school. A large collection of views showed various classes in sculpture, masonry, carpentering, decorative painting, etc.

The final session of the convention, held on the morning of the third day, brought out three addresses. The first of these was by Dr. T. N. Carver, Professor of Economics, Harvard University. Under the title "The Economic Significance of Industrial Education," he maintained that the most important element in commercial production was the human factor. As examples, he asserted that Scotland and New England had grown wealthy in the midst of few natural resources by reason of the superior efficiency of their labor, while, on the other hand, Spain and Southern Italy had grown poor in the midst of abundant resources because of the inferiority of labor. Industrial education was held to be the means of bringing about a better distribution of men among the different grades of employment, raising many from unskilled to skilled classes. The predominating factor in waste labor was claimed to be the unskilled class, so that the taking of a hundred unskilled laborers from the existing supply of any concern would detract very little from present productive power because there is enough of this class. Four characteristic forms of waste labor was described; the unemployed, the imperfectly employed, the improperly employed and the voluntarily idle. The imperfectly employed was held to include all those who were doing less skilled work than they might be doing with better training—a condition which was to be cured by industrial education.

Miss E. B. Butler, of the Municipal Bureau of Research, New York City, discussed "Industrial Education and the Community," pointing out a number of causes of unsatisfactory manufactured products and of social disintegration. The pressure of business competition was described as placing undue emphasis on immediate output, which caused the employee to turn out work so that it would just pass inspection. Secondly, the unindividual character of work performed by the average operative in a modern factory was held to have taken away largely pride in high quality of production. Thirdly, the present high development of machinery has introduced a large amount of unskilled labor into shop processes, which breeds instability of employment, both through the workman and the employer. A fourth disturbing element was seen in the race prejudice between American-born workers and immigrants. Better wages were declared necessary for the reduction of poverty, but increase of wages should be dependent on increased efficiency of the worker. That is, factory hands should be trained so that their employers can raise their wages proportional to the extent that waste of material and damage to machinery is done away with. Employees also need to be educated individually in order that they may not only be more efficient workmen, but that they may be more intelligent members of society.

The address of Mr. C. H. Winslow, representing the American Federation of Labor, was a reassurance that organized labor was thoroughly in sympathy with movements toward increased facilities for industrial training. He held that the future progress of the whole republic depended upon the schools, and that the most important of all problems was this one of training the hand and mind of American youth. He believed that the real hope for suitable industrial education lay in schools operated by public funds, rather than in schools operated privately for profit, or supported by philanthropy or by corporations. He warned his hearers against the possibility of having the public schools dominated by the industrial policy of private corporations. He also held that, in zeal for industrial education, care must be shown not to hold to the single aim of turning out good mechanics at the sacrifice of good citizens. Industrial courses he would have directed to every point alike, embodying physical, industrial, moral and purely intellectual training. He agreed that half-time, part-time, cooperative and similar courses were going to be popular and offered practical, immediate and invaluable assistance, but he feared that undue emphasis would be placed on the school rather than on the product. The teachers of trades and occupations were warned to keep up with shop practice and processes in establishments which are doing regular productive work, lest they should fail as teachers for industrial schools. Finally, he held that the public school system at present of the country failed entirely to prepare its pupils for productive labor, and that it must be radically changed. The addition of a few trade schools in our larger cities, or manual training departments to supplement Latin and Greek curricula, would not be sufficient.

BOILER TUBE CORROSION at an exceptionally rapid rate is recorded in a recent number of the "Engineer" (London). A large coasting steamer was fitted in 1909 with two new single-end Scotch marine boilers 12 ft. 8 ins. diameter and 10 ft. 6 ins. long. Each boiler has 166 plain tubes 3¼ ins. inside diameter and 0.144-in. thick (No. 9 W. G.); also 66 stay tubes of the same diameter and 5-16-in. thick. The tubes are of iron. The boiler pressure was 163 lbs. In March, 1910, one of the tubes collapsed and two men were badly scalded, one of them dying from the effects. Examination showed that in less than one year all the plain tubes were practically worn out, but instead of the usual pitting the corrosion was practically uniform, but greater on the under side of the tubes. The maximum thickness found in the plain tubes gaged after the accident was 0.1116-in. at the bottom, while for the whole tube the thickness varied from 0.064-in. to 0.144-in.. The stay tubes were only slightly corroded, and on the under side only. No scale was found on the tubes, due apparently to the use of fresh water, an auxiliary feed of sea water being used only occasionally. The corrosion is attributed by the "Engineer" to the action of this water on the tubes, attacking the underside as it rushed upward. The opinion is expressed, also, that the boilers would have escaped injury if they had been filled with sea water and worked with sea water until a thin protective scale had been formed. This practice is favored by and commonly used by those in charge of steamship boilers.

Cost Data on the Panama Canal.

The "Canal Record" for Nov. 9, 1910, published three tables, which we reprint herewith, giving in detail the general expenditures of the Isthmus of Panama from the time of the American occupation until Sept. 30, 1910, and also the unit costs of lock, dam and spillway construction on the Canal. The notes at the bottom of the page have considerable bearing on the items.

TABLE I.—GENERAL STATEMENT OF CONSTRUCTION EXPENDITURES ON THE PANAMA CANAL, TO SEPT. 30, 1910.
(Includes administrative and general expenses, but does not include general items or expenditures for sanitation, hospitals, and civil government.)

Items.	First Quarter, Fiscal Year, 1911. Quantities, cu. yds.	Amount.	Unit cost.	To June 30, 1910. Quantities, cu. yds.	Amount.	Unit cost.	Total to Sept. 30, 1910. Quantities, cu. yds.	Amount.	Unit cost.
Atlantic Division—									
1 Dry excavation, prism	.....	$1,775.05	.....	1,476,824	$1,002,250.14	$0.6787	1,476,871	$1,004,025.19	$0.6796
2 Dredging excavation, prism	1,383,794	367,514.31	$0.2656	18,143,783	4,229,415.40	.2331	19,527,577	4,596,929.71	.2354
Gatun Spillway—									
3 Dry excavation	48,606	20,567.93	.4232	1,418,819	1,039,275.36	.7325	1,467,425	1,059,843.29	.722
4 Preparing foundations	8,187	7,398.91	.9037	4,723	21,364.85	4.5236	12,910	28,763.76	2.227
5 Masonry	10,510	82,086.31	7.8103	84,096	732,487.40	8.7101	94,606	814,573.74	8.607
6 Ironwork	.....	.....	.....	.....	387.86	.....	.....	387.86	.....
7 Back filling	7,156	409.04	.0572	1,781	1,099.24	.6172	8,937	1,508.28	.1688
Total	.....	$110,462.22	.....	.....	$1,794,614.71	.....	.....	$1,905,076.93	.....
Gatun Dam—									
8 Dredging excavation	.....	.....	.....	38,425	$20,041.19	$0.5216	38,425	$20,041.19	$0.5216
9 Dry filling	632,987	$244,615.25	$0.3864	4,799,819	1,953,565.42	.4070	5,432,806	2,198,180.67	.4046
10 Hydraulic filling	1,326,335	275,382.42	.2076	3,653,222	1,043,646.57	.2857	4,979,557	1,319,028.99	.2649
11 Paving	18,374	5,726.74	.3117	22,037	6,788.50	.3081	40,411	12,515.24	.3097
Total	.....	$525,724.41	.....	.....	$3,024,041.68	.....	.....	$3,549,766.09	.....
Gatun Locks—									
12 Dry excavation	217,532	$170,115.74	$0.7820	4,079,520	$2,708,600.00	$0.6639	4,297,052	$2,878,715.74	$0.6699
13 Dredging excavation	.....	.....	.....	488,533	89,406.16	.1830	488,533	89,406.16	.1830
14 Preparing foundations, excavation	23,955	52,630.73	2.1971	33,843	98,502.50	2.9105	57,798	151,133.23	2.6149
16 Preparing foundations, filling	22,334	4,089.32	.1839	17,883	10,607.43	.5932	40,217	14,696.75	.3654
17 Masonry	246,407	1,730,842.49	7.0243	513,803	4,000,909.02	7.7868	760,210	5,731,751.51	7.5387
18 Ironwork	.....	156,437.33	.....	.....	252,666.68	.....	.....	409,104.01	.....
19 Back filling	48,786	45,504.20	.9327	4,190	5,199.81	1.2410	52,976	50,704.01	.9571
Total	.....	$2,159,619.81	.....	.....	$7,165,891.60	.....	.....	$9,325,511.41	.....
20 Gatun-Mindi levee	50,459	$10,554.46	$0.2092	126,002	$57,914.73	$0.4596	176,461	$68,469.19	$0.3880
21 Colon breakwater	6,862	$128,084.57	18.6658	.....	$56,120.86	.....	6,862	$184,205.43	$26.8443
Total construction cost, Atlantic Divis'n	.....	$3,303,734.83	.....	.....	$17,330,249.12	.....	.....	$20,633,983.95	.....
22 Plant and equipment to be absorbed in construction costs after Sept. 30	.....	.....	.....	.....	.....	.....	.....	$5,117,500.90	.....
Total expenditures, Atlantic Division	.....	.....	.....	.....	.....	.....	.....	$25,751,484.85	.....
Central Division—									
23 Dry excavation, prism	4,506,272	$3,044,136.15	$0.6755	58,815,543	$55,254,020.04	$0.9394	63,321,815	$58,298,156.19	$0.9207
24 Clearing Canal line, without excavation	.....	.....	.....	(Acres)2,098	134,857.24	64.2789	(Acres)2,098	134,857.24	64.2789
25 Dredging excavation	.....	.....	.....	.....	9,798.40	.....	.....	9,798.40	.....
Total construction cost, Central Division	.....	$3,044,136.15	.....	.....	$55,398,675.68	.....	.....	$58,442,811.83	.....
26 Plant and equipment to be absorbed in construction costs after Sept. 30	.....	.....	.....	.....	.....	.....	.....	$2,364,963.49	.....
Total expenditures, Central Division	.....	.....	.....	.....	.....	.....	.....	$60,807,775.32	.....
Pacific Division—									
27 Dry excavation, prism	890	$2,470.53	$2.7758	239,173	$211,150.55	$0.8828	240,063	$213,621.08	$0.8899
28 Dredging excavation, prism	1,496,336	$490,256.60	$0.3276	23,037,330	$5,512,096.04	$0.2393	24,533,666	$6,002,352.64	$0.2447
Pedro Miguel Dam—									
29 Dry excavation	.....	.....	.....	.....	$925.47	.....	.....	$925.47	.....
30 Dry filling	.....	$5.06	.....	260,852	$126,600.66	$0.4853	260,852	$126,605.72	$0.4854
31 Hydraulic filling	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	.....	$5.06	.....	.....	$127,526.13	.....	.....	$127,531.19	.....
Pedro Miguel Locks—									
32 Dry excavation	.....	.....	.....	1,018,657	$987,900.41	$0.9698	1,018,657	$987,900.41	$0.9698
33 Preparing foundations	27,604	85,068.31	3.0796	44,948	141,639.15	3.1512	72,552	226,647.46	3.1239
34 Masonry	143,430	700,410.27	4.8833	166,869	1,102,812.40	6.6088	310,299	1,803,222.67	5.8112
35 Ironwork	.....	57,248.80	.....	.....	264,360.67	.....	.....	321,609.47	.....
36 Back filling	6,905	4,786.52	.6932	9,616	3,016.58	.3137	16,521	7,803.10	.4723
Total	.....	$847,453.90	.....	.....	$2,499,729.21	.....	.....	$3,347,183.11	.....
Miraflores Dams and Spillway—									
37 Dry filling	26,408	$17,445.79	$0.6606	320,901	$313,884.60	$0.6026	347,309	$331,330.39	$0.6054
38 Hydraulic filling	.....	39.39	.....	.....	4,077.86	.....	.....	4,117.25	.....
39 Masonry, core wall	.....	.....	.....	.....	429.51	.....	.....	429.51	.....
40 Dry excavation	.....	.....	.....	14,536	19,991.26	1.3753	14,536	19,991.26	1.3753
Total	.....	$17,485.18	.....	.....	$338,383.23	.....	.....	$355,868.41	.....
Miraflores Locks—									
41 Dry excavation, diversions	.....	.....	.....	5,885	$2,028.98	$0.3448	5,885	$2,028.98	$0.3448
42 Dry excavation, in locks	.....	.....	.....	1,350,135	1,422,325.30	1.0535	1,350,135	1,422,325.30	1.0535
43 Dredging excavation	.....	.....	.....	309,647	142,379.66	.4598	309,647	142,379.66	.4598
44 Hydraulic excavation	.....	3,613.07	.....	.....	.....	.....	.....	3,613.07	.....
45 Preparing foundations	38,128	88,072.95	2.3099	64,036	140,621.82	2.1960	102,164	228,694.77	2.2385
46 Masonry	27,835	169,918.29	6.1043	1,630	13,224.18	8.1129	29,465	183,142.47	6.2156
47 Ironwork	.....	53,012.85	.....	.....	95,440.87	.....	.....	148,453.72	.....
48 Back filling	12,465	6,659.67	.5343	530,291	101,960.20	.1923	542,756	108,619.87	.2001
Total	.....	$321,276.83	.....	.....	$1,917,981.01	.....	.....	$2,239,257.84	.....
La Boca Locks and Dams (abandoned)—									
49 Dry excavation	.....	.....	.....	78,233	$158,343.29	$2.0240	78,233	$158,343.29	$2.0240
50 Construction, dam	.....	.....	.....	.....	315,350.07	.....	.....	315,350.07	.....
51 Construction, locks	.....	.....	.....	.....	159,306.40	.....	.....	159,306.40	.....
Total	.....	.....	.....	.....	$632,999.76	.....	.....	$632,999.76	.....
52 Naos Island breakwater	.....	$319.10	.....	.....	$36,867.76	.....	.....	$37,186.86	.....
Total construction cost, Pacific Division	.....	$1,679,267.20	.....	.....	$11,276,733.69	.....	.....	$12,956,000.89	.....
53 Plant and equipment to be absorbed in construction costs after Sept. 30	.....	.....	.....	.....	.....	.....	.....	$3,489,908.67	.....
Total expenditures, Pacific Division	.....	.....	.....	.....	.....	.....	.....	$16,445,909.56	.....
Total expenditures, constr. and engr'n'g	.....	.....	.....	.....	.....	.....	.....	$103,005,169.73	.....

NOTES.—Item 7—Gatun Spillway Back Filling: Material obtained mainly from excavation in preparing foundations, charged to Item No. 4.
Item 21—Colon Breakwater: Unit cost computed on basis of yardage placed in breakwater. Expenditures represent preliminary work, such as tracks, trestles, etc.
Item 38—Miraflores Dams and Spillway: Hydraulic filling. Expenditures represent preliminary work, such as pipe lines, flumes, etc.
Item 44—Miraflores Locks: Hydraulic excavation. Expenditures represent preliminary work.
Item 52—Naos Island Breakwater: Expenditures represent cost of trestling only. Filling is done by Central Division and the cost thereof charged to Item No. 23.
Items 22, 26 and 53—Plant: The expenditures for plant and equipment are absorbed into construction costs on the basis of estimated total cost of plant, and the estimated quantities of work to be done. The amounts shown under these items the balance to be absorbed into construction costs after Sept. 30.
General—When excavated material is used in filling, such as dams, back filling, etc., the cost of dumping only is charged to the items benefited.

TABLE II.

DAM CONSTRUCTION, PANAMA CANAL.

Items.	Gatun Dam. July.	Gatun Dam. August.	Gatun Dam. Sept.	Gatun Dam. Total.	Gatun-Mindi Levee. July.	Gatun-Mindi Levee. August.	Gatun-Mindi Levee. Sept.	Gatun-Mindi Levee. Total.	Miraflores Dam. July.	Miraflores Dam. August.	Miraflores Dam. Sept.	Miraflores Dam. Total.
Dry Fill—Quantities—cu. yds.	180,111	229,774	223,102	632,987	19,619	17,591	13,249	50,459	4,280	10,898	11,220	26,408
Clearing site	$0.0056	$0.0033	$0.0068	$0.0053	....	....	....	....	....	....	....	....
Tracks	.0040	.0564	.0583	.0678	....	....	....	....	$0.0457	$0.1296	$0.1733	$0.1333
Trestle	.0028	.0042	.0078	.0051	....	....	....	....	....	....	....	....
Transportation	.0142	.0618	.1406	.0760	....	....	....	....	.1442	.1537	.1712	.1597
Filling	.0909	.0965	.0869	.0915	$0.1207	$0.0813	$0.0985	$0.1011	.0703	.0301	.1264	.0775
Maintenance of equipment	.0083	.0074	.0147	.0102	....	....	....	....	.0524	.0443	.0460	.0463
Plant arbitrary	.0770	.0770	.0770	.0770	.0770	.0770	.0770	.0770	.1600	.1600	.1600	.1600
Division expense	.0251	.0222	.0192	.0220	.0170	.0110	.0117	.0135	.0201	.0156	.0309	.0228
Total division cost	$0.3179	$0.3288	$0.4113	$0.3549	$0.2147	$0.1693	$0.1872	$0.1916	$0.4927	$0.5303	$0.7078	$0.5986
Administrative and general expenses	$0.0339	$0.0284	$0.0329	$0.0315	$0.0208	$0.0151	$0.0159	$0.0176	$0.0779	$0.0427	$0.0723	$0.0610
Total cost	$0.3518	$0.3572	$0.4442	$0.3864	$0.2355	$0.1844	$0.2031	$0.2092	$0.5706	$0.5730	$0.7801	$0.6606

Items.	Gatun Dam. July.	Gatun Dam. August.	Gatun Dam. Sept.	Gatun Dam. Total.
Paving—Quantities—cu. yds.	7,602	5,236	5,536	18,374
Clearing site	$0.0056	$0.0033	$0.0068	$0.0053
Filling	.2118	.1031	.2056	.1789
Plant arbitrary	.0770	.0770	.0770	.0770
Division expenses	.0300	.0140	.0160	.0212
Total division cost	$0.3244	$0.1974	$0.3054	$0.2824
Administrative and general expenses	$0.0367	$0.0163	$0.0310	$0.0293
Total cost	$0.3611	$0.2137	$0.3364	$0.3117

[These costs are tabulated per cu. yd. for quarter ending Sept. 30.]

Items.	Gatun Dam. July.	Gatun Dam. August.	Gatun Dam. Sept.	Gatun Dam. Total.
Hydraulic Fill—Quantities—cu. yds.	462,092	406,606	457,637	1,326,335
Clearing site	$0.0056	$0.0033	$0.0068	$0.0053
Clearing for dredge	.0069	.0084	.0054	.0069
Dredging	.0644	.0594	.0729	.0658
Relay pumps	.0026	.0023	.0008	.0019
Pipe lines	.0268	.0112	.0179	.0189
Wood flumes	....	....	....	....
Power	.0124	.0130	....	.0083
Small boats	.0010	.0011	.0014	.0011
Maintenance of equipment	.0321	.0428	.0108	.0280
Plant arbitrary	.0490	.0490	.0490	.0490
Division expense	.0084	.0090	.0057	.0077
Total division cost	$0.2092	$0.1995	$0.1707	$0.1929
Administrative and general expenses	$0.0131	$0.0172	$0.0141	$0.0147
Total cost	$0.2223	$0.2167	$0.1848	$0.2076

TABLE III.

LOCKS AND SPILLWAYS CONSTRUCTION, PANAMA CANAL.

Items.	Gatun Spillway. July.	Gatun Spillway. August.	Gatun Spillway. Sept.	Gatun Spillway. Total.	Gatun Locks. July.	Gatun Locks. August.	Gatun Locks. Sept.	Gatun Locks. Total.	Pedro Miguel Locks. July.	Pedro Miguel Locks. August.	Pedro Miguel Locks. Sept.	Pedro Miguel Locks. Total.	Miraflores Locks. July.	Miraflores Locks. August.	Miraflores Locks. Sept.	Miraflores Locks. Total.
Dry excavation—Quantities—cu. yds.	15,436	10,508	22,662	48,606	70,503	76,681	70,348	217,532	....	....	....	....	....	....	....	....
Drilling	....	....	$0.0004	$0.0002	$0.0288	$0.0234	$0.0215	$0.0245	....	....	....	....	....	....	....	....
Blasting	....	....	.0106	.0049	.0486	.0322	.0392	.0398	....	....	....	....	....	....	....	....
Loading by power	$0.0586	$0.0518	.0747	.0646	.1002	.0546	.0779	.0769	....	....	....	....	....	....	....	....
Tracks	.0100	.1273	.0644	.0697	.1644	.1416	.0969	.1345	....	....	....	....	....	....	....	....
Transportation	.0634	.0427	.0654	.0602	.1536	.1445	.1351	.1444	....	....	....	....	....	....	....	....
Trestles	....	....	.0035	.0016	....	....	....	....	....	....	....	....	....	....	....	....
Pumps	....	....	....	....	.0312	.0485	.0289	.0365	....	....	....	....	....	....	....	....
Power	....	....	....	....	.0103	.0080	.0085	.0089	....	....	....	....	....	....	....	....
Maintenance of equipment	.0497	.0227	.0593	.0484	.0566	.0650	.0969	.0850	....	....	....	....	....	....	....	....
Plant arbitrary	.1100	.1100	.1100	.1100	.1100	.1100	.1100	.1100	....	....	....	....	....	....	....	....
Division expense	.0206	.0308	.0226	.0238	.0524	.0501	.0269	.0434	....	....	....	....	....	....	....	....
Total division cost	$0.3132	$0.3853	$0.4109	$0.3744	$0.7961	$0.6779	$0.6418	$0.7045	....	....	....	....	....	....	....	....
Admin. and general expense	$0.6027	$0.0297	$0.0482	$0.0488	$0.0842	$0.0820	$0.0658	$0.0775	....	....	....	....	....	....	....	....
Total cost	$0.3759	$0.4150	$0.4591	$0.4232	$0.8803	$0.7599	$0.7076	$0.7820	....	....	....	....	....	....	....	....
Preparing foundations, excavation—Quantities—cu. yds.	3,614	1,973	2,600	8,187	5,850	10,575	7,530	23,955	4,410	12,789	10,405	27,604	*11,980	17,548	8,600	38,128
Drilling	....	....	....	....	$0.3490	$0.1401	$0.1945	$0.2082	$0.6486	$0.3308	$0.5323	$0.4576	$0.5896	$0.3426	$0.2931	$0.4316
Blasting	....	....	....	....	.1712	.2692	.1267	.2005	.1873	.0874	.1176	.1148	.1348	.0762	.1270	.1060
Loading by power	....	....	....	....	.1366	.1253	.1717	.1427	.1795	.1959	.2828	.2260	.1834	.1361	.2337	.1730
Loading by hand	$0.6086	$0.7439	$0.4556	$0.5926	1.1666	.5596	.8112	.7870	1.5536	.4239	.6275	.6811	.5750	.3932	1.0872	.5920
Transportation	....	....	....	....	.2059	.1151	.0897	.1201	.3206	.2682	.1877	.2462	.1487	.1308	.1906	.1490
Tracks (trestles)	....	.0240	....	.0058	....	.0196	.0259	.0168	.2508	.2349	.1196	.1940	.3533	.1667	.1747	.2272
Dumps	....	....	....	....	....	....	....	....	.3799	.0613	.0537	.1093	....	....	....	....
Pumps (power)	....	....	....	....	....	.0021	....	.0010	.0577	.0336	.0342	.0377	.1213	.0545	.0531	.0752
Maintenance of equipment	.0215	....	.0023	.0102	.1549	.1050	.1747	.1391	.1937	.1361	.1198	.1392	.0104	.0692	.0630	.0428
Plant arbitrary	.1100	.1100	.1100	.1100	.1100	.1100	.1100	.1100	.6300	.6300	....	.3925	.0773	.0800	.0800	.0792
Division expense	.0892	.1000	.0548	.0811	.2749	.1415	.1844	.1875	.2320	.0954	.1158	.1249	.1360	.0740	.1472	.1100
Total division cost	$0.8293	$0.9788	$0.6227	$0.7907	$2.5691	$1.5875	$1.8598	$1.9129	$4.6337	$2.4975	$2.1910	$2.7233	$2.3090	$1.4933	$2.5496	$1.9878
Admin. and general expense	$0.1094	$0.1226	$0.0825	$0.1040	$0.4223	$0.2250	$0.2602	$0.2842	$0.9301	$0.2339	$0.2635	$0.3563	$0.5263	$0.1765	$0.3346	$0.3221
Total cost	$0.9387	$1.1014	$0.7052	$0.9037	$2.9914	$1.8125	$2.1200	$2.1971	$5.5638	$2.7314	$2.4545	$3.0796	$2.8353	$1.6698	$2.8842	$2.3099
Preparing foundations, filling—Quantities—cu. yds.	....	....	....	....	20,296	1,938	....	22,234	....	....	....	....	....	....	....	....
Filling	....	....	....	....	$0.1757	$0.2695	....	$0.1839	....	....	....	....	....	....	....	....
Total cost	....	....	....	....	$0.1757	$0.2695	....	$0.1839	....	....	....	....	....	....	....	....
MASONRY. Concrete—Quantities—cu. yds.	2,232	3,237	4,250	9,719	77,470	77,635	69,039	224,144	40,937	50,583	50,243	141,763	3,672	5,755	17,795	27,222
Cement	$1.9271	$1.9014	$1.7680	$1.8490	$1.8961	$1.8947	$1.8359	$1.8771	$1.5332	$1.9369	$1.4323	$1.6414	$1.5407	$2.3902	$1.3999	$1.6282
Stone	2.7538	2.7330	2.0280	2.4294	2.3620	2.3486	2.2559	2.3247	.9545	.9360	.8353	.9056	1.0978	.9677	.8434	.9040
Sand	.7679	.7138	.5376	.6492	.7269	1.0152	1.0091	.9137	.2206	.3704	.3700	.3270	.3671	.3827	.3736	.3747
Mixing	.5566	.3264	.2413	.3420	.1325	.1937	.2162	.1790	.1760	.1263	.1351	.1437	1.2084	.9079	.5839	.7557
Total cost	$6.0054	$5.6746	$4.5749	$5.2696	$5.1175	$5.4522	$5.3171	$5.2945	$2.8843	$3.3696	$2.7727	$3.0177	$4.2140	$4.7385	$3.2008	$3.6626
Large Rock—Quantities—cu. yds.	284	336	171	791	6,531	8,051	7,681	22,263	527	681	459	1,667	....	275	338	338
Cost	$1.0342	$1.8512	$2.1869	$1.6305	$1.4424	$1.3815	$1.2412	$1.3510	$2.0534	$1.5038	$0.6508	$1.4427	....	....	$0.4036	$0.4036
Masonry—Quantities—cu. yds.	2,516	3,573	4,421	10,510	84,001	85,686	76,720	246,407	41,464	51,264	50,702	143,430	3,672	6,030	18,133	27,835
Concrete	$5.3274	$5.1411	$4.3980	$4.8731	$4.7196	$4.9399	$4.7847	$4.8165	$2.8470	$3.3248	$2.7475	$2.9826	$4.2140	$4.5224	$3.1411	$3.5819
Large rock	.1167	.1741	.0846	.1227	.1121	.1298	.1243	.1220	.0261	.0200	.0059	.0168	....	....	.0075	.0049
Wood forms	.5778	.6465	.5235	.5783	.2975	.4154	.4204	.3767	.3491	.2719	.2819	.2907	.5658	.4433	.5837	.5379
Steel forms	....	....	....	....	.0906	.0915	.1114	.0974	.0931	.0775	.0614	.0783	.3540	.1791	.0880	.1429
Placing	.6831	.7612	.6207	.6834	.3155	.2526	.2813	.2830	.3119	.2070	.2492	.2523	.3156	.2117	.3591	.3214
Reinforcements	....	....	....	....	.0209	.0284	.0374	.0287	.0085	.0569	.0684	.0455	....	.0029	.3815	.2492
Pumps	....	....	....	....	.0262	.0483	.0278	.0344	.0577	.0336	.0342	.0408	.1149	.0545	.0531	.0616
Power	....	....	....	....	.0517	.0633	.0645	.0597	.0637	.0642	.0398	.0554	....	.0132	.0116	.0104
Maintenance of equipment	.3616	.4351	.3393	.3772	.1312	.1847	.2895	.1991	.1008	.1294	.1838	.1403	.2407	.0935	.1774	.1676
Plant arbitrary	.6160	.6160	.6160	.6160	.6850	.6850	.6850	.6850	.6646	.6658	.6658	.6655	.4500	.4500	.4500	.4500
Division expense	.2631	.2546	.1501	.2127	.1011	.1145	.1243	.1130	.0865	.0575	.0653	.0686	.1907	.1315	.1080	.1240
Total division cost	$7.9457	$8.0286	$6.7322	$7.4634	$6.5514	$6.9534	$6.9506	$6.8155	$4.6040	$4.9086	$4.3832	$4.6348	$6.4466	$6.1021	$5.3410	$5.6518
Admin. and general expense	$0.3483	$0.3756	$0.3229	$0.3469	$0.1572	$0.2143	$0.2592	$0.2088	$0.2460	$0.2342	$0.2649	$0.2485	$0.7390	$0.4250	$0.4040	$0.4527
Total cost	$8.2940	$8.4042	$7.0551	$7.8103	$6.7086	$7.1677	$7.2098	$7.0243	$4.8500	$5.1428	$4.6481	$4.8833	$7.1856	$6.5271	$5.7450	$6.1045
Backfilling—Quantities—cu. yds.	3,614	942	2,600	7,156	3,458	18,918	26,410	48,786	3,967	2,380	578	6,905	6,110	6,355	....	12,465
Loading by power	....	....	....	....	....	$0.0049	$0.0519	$0.0300	$0.1522	$0.2892	$0.2171	$0.2044	....	....	....	....
Transportation	....	....	....	....	....	.0119	.0900	.0533	.1129	.1048	....	.1007	$0.1317	$0.0580	....	$0.1040
Tracks	....	....	....	....	$2.8480	.3580	.2382	.4697	.0330	.0645	....	.0410	.0831	.1290	....	.1035
Filling	$0.0023	....	$0.0363	$0.0012	.0042	.1781	.1106	.1293	.0989	.0536	.0461	.0790	.1320	.0253	....	.0874
Maintenance of equipment	....	....	....	....	....	.0054	.0845	.0370	.0390	.0271	.0083	.0324	.0360	.0239	....	.0396
Plant arbitrary	.1100	....	....	.0333	.1100	.0110	.0737	.0519	.1000	.1000	.1000	.1000	.1000	.1000	....	.1000
Division expense	.0003	....	.0043	....	.1632	.0517	.0434	.0351	.0312	.0374	.0199	.0324	.0313	.0143	....	.0226
Total division cost	$0.1126	....	$0.0408	$0.0367	$3.1254	$0.6210	$0.6723	$0.8263	$0.5672	$0.6766	$0.3914	$0.5899	$0.5741	$0.3445	....	$0.4571
Admin. and general expense	$0.0004	....	$0.0066	$0.0005	$0.8344	$0.0933	$0.0860	$0.1064	$0.1210	$0.0881	$0.0445	$0.1033	$0.1215	$0.0346	....	$0.0772
Total cost	$0.1130	....	$0.0474	$0.0372	$3.4598	$0.7143	$0.7583	$0.9327	$0.6882	$0.7647	$0.4359	$0.6932	$0.6956	$0.3791	....	$0.5343

Annual Meeting of the Society of Naval Architects and Marine Engineers.

On Nov. 17 and 18, 1910, the Society of Naval Architects and Marine Engineers held its 18th annual meeting, with President Stevenson Taylor in the chair. As usual, the time of the meeting was almost wholly devoted to the reading and discussion of technical papers, of which there were eleven, opening with one by the noted ship designer, Sir William H. White.

Only two of the papers dealt with tests or definite experimental results. One of these gave a record of deflection tests of water-tight bulkheads with different arrangements of the studding. The other gave speed and coal-consumption results for a steam yacht first equipped with compound steam turbines and later fitted with a reciprocating engine in place of the high-pressure turbine. Experimental work was touched on in a more general way in a paper on the gyroscope, which contained reference to extensive experimenting done at the Washington Navy Yard under the direction of Mr. D. W. Taylor.

The always live subject of building up the American merchant marine by the help of ship subsidies and similar devices came up for frequent mention, with strong remarks in its favor, especially by the President. Unlike previous meetings, this meeting did not enter into a general discussion of the subject or take action upon it.

SOCIETY BUSINESS.—The Society is not growing rapidly, but its finances appear to be sound. Due to a more businesslike treatment of members who were careless about paying their dues, the past year actually showed a decrease in membership, from 796 to 769. The year's operations are summarized by the following figures:

Receipts	$10,715.67
Expenditures	10,797.65
Deficit	81.98
Net resources	23,984.80

Most of the latter amount represents cash or ready assets.

The long service of the former President, Admiral Francis T. Bowles, was duly remembered in formal resolutions of thanks, and a cup was presented to Mr. Bowles as a memorial of his services. An amendment to the by-laws was passed, under which junior memberships must terminate at the age of 26, by either transfer to another grade or resignation.

The election of officers resulted as follows: Vice-Presidents (elected by the Council), Mr. George W. Quintard (Quintard Iron Works, New York), and Mr. W. M. McFarland (Babcock & Wilcox Co., New York); Members of Council (elected by the membership), Mr. W. I. Babcock (New York City), Prof. W. F. Durand (Stanford University, Cal.), Mr. N. G. Herreshoff (Herreshoff Mfg. Co., Bristol, R. I.), Mr. H. I. Cone (Engineer-in-Chief, U. S. Navy, Washington, D. C.), Mr. J. H. Linnard (Philadelphia, Pa.), Mr. W. A. Post (Newport News S. B. & D. D. Co., Newport News, Va.), Rear-Admiral W. H. Brownson (Washington, D. C.), and Mr. J. R. Andrews (Hyde Windlass Co., Bath, Me.). To succeed Horace See, deceased, the Council elected Mr. F. L. Du Bosque (Asst. Engr., Pennsylvania R. R. Co., Jersey City, N. J.), as Member of Council. There was no election of a President, as Mr. Stevenson Taylor entered office a year ago, and the term of office is three years.

In a clear and well-balanced paper entitled "Notes on the Armaments of Battleships," Sir William White discussed the question of what number and what sizes of guns should be chosen for the modern battleship. He expressed a very decided opinion in favor of employing a small number of large guns and a strong secondary battery of a single caliber. The arrangement of four center-line turrets, each mounting two guns, as originated in the U. S. battleship "Michigan" and since extensively copied elsewhere, appeals to him as best; he prefers the 12-in. caliber for the maximum guns and 6-in. for the secondary battery. The following quotations from the paper are expressive:

> The trend of naval opinion throughout the world during recent years has been against the perpetuation of the system which discarded all guns except those of large caliber and 3-in. guns for use against the attacks of torpedo vessels. Consequently, there is a danger of appearing "to flog a dead horse" by further advocacy of secondary armaments on this occasion, and no more need be said thereupon.
>
> * * * The main reason for preferring a caliber of about 6 ins. is that experience proves projectiles of about 100 lbs. weight to be the maximum which can be "man-handled" continuously and rapidly, while accuracy of fire even at long range can be combined with rapidity of discharge and remarkable effectiveness against the lightly armored, unarmored and vulnerable points of warships. Personally, I have always maintained the view that these quick-firing guns, their crews and their supplies of ammunition should have a remarkable amount of armor protection against the fire of similar guns carried by an enemy.
>
> * * * There are two positions for heavy guns which by common consent confer supreme advantages, and are always utilized. These positions are at the center line of the deck; one commanding right-ahead fire, with large arcs of horizontal training reaching well abaft the beam on each side; the other possessing corresponding command right astern and over large arcs of training reaching well before the beam. Until the "Michigan" and "South Carolina" were designed, it was the general practice to mount one or two heavy guns—two in nearly all cases—in each of these positions. Superposed turrets were tried in some cases, and 8-in. guns imposed turrets were tried in some cases, and 8-in. guns were mounted in the upper emplacement; but this practice did not find much favor, and may be considered to have dropped out of use. It was a new and bold departure in the "Michigan" and "South Carolina" to place two turrets in each of the supreme positions, and to arrange for firing the guns in one turret over the top of the other turret. That arrangement proved successful, however, and has been largely adopted in recent ships of all navies.
>
> * * * The writer desires to place on record his personal opinion that in no case is it desirable to carry more than eight heavy guns in a single ship, that these guns are best arranged in four positions, as in the "Michigan" class, and that they should be supplemented by a powerful and well-protected secondary armament.
>
> * * * The writer ventures to doubt the accuracy of much that has been written both as to the vastly greater relative power of 13.5-in. shells and as to the absolute necessity for adopting guns of that caliber in order to secure effective shell fire.

Discussion of the paper brought a thoroughgoing support for the views expressed. Professor Wm. Hovgaard directed special attention to the fact that big-gun ships are weak against torpedo attack, and he considers that the danger from torpedo attack is about equal to the danger from artillery attack. Mr. D. W. Taylor pointed out that while four positions for the big guns seem best, they will not accommodate as many maximum guns as the officers want, except by placing three guns in each turret. Admiral W. L. Capps dwelt on the great importance of fog and other unfavorable weather conditions in limiting battle-ranges, in spite of the fact that firing ranges have increased from 2,000 yds. to 8,000 and even 10,000. The short battle-range, of course, speaks for a lesser number of large guns and a stronger secondary battery.

In a semi-philosophical, semi-historical paper entitled "The History and Economic Value of Canals, with Special Reference to Cape Cod Canal," Commodore Jacob W. Miller presented a very attractive view of the status of the Cape Cod Canal undertaking. According to his figures, it is bound to prove a very profitable enterprise, and he believes it will be the northern section of the first of the series of channels which will ultimately be built to carry domestic commerce to connect with the foreign trade passing through the Panama Canal.

Mr. Charles H. Cramp continued his history of screw propulsion, begun by a paper at last year's meeting of the Society, in a second paper on "Evolution of Screw Propulsion in the United States." One of the episodes recounted in this paper is the purchase of three warships by the United States early in the Civil War, the "New Ironsides," the "Monitor" and the "Galena," and the influence which the duel between the "Monitor" and the "Merrimac" exerted upon shipbuilding. A statement in the paper that the first screw-propelled tug was the "Sampson," built by Cramps, was disputed in the discussion. Mr. W. I. Babcock presented some evidence to show that a screw tug named "Reindeer" existed three years before the "Sampson," and Mr. J. E. Hyde mentioned a 125-ft. twin-screw iron steamer, named "Bangor," built in 1845.

A valuable paper on the subject "Floating Drydocks in the United States; Relative Value of Wood and Steel for Their Construction," by Mr. William T. Donnelly, described several large drydocks, among them one or two having wooden pontoons and steel wings, for which combination many advantages can be claimed. The following table of relative costs of floating drydocks was given:

COST PER TON OF LIFTING POWER.

Balanced sectional timber dock with centrifugal pumps	$32 per ton.
All wood pontoon dock with continuous wings	35 "
Pontoon dock, steel wings and wooden pontoons	42 "
All steel pontoon dock	57 "
Government steel dock, Dewey type	62 "

The following statistical figures should be of general interest:

> The building of timber floating drydocks in the United States is very old, and there are now in use in the U. S. of New York 64 floating drydocks, all of wood, ranging in tonnage from 400 to 12,000 tons, and in the United States there are 91 floating drydocks, three of steel, one with steel wings, ranging in tonnage from 2,500 to 18,000 tons, having a total tonnage of 228,500 tons and an average tonnage of 2,500 tons.
>
> The only steel commercial floating drydock is at the works of the Great Lakes Shipbuilding Co., Detroit, Mich. The only other steel floating drydocks in the United States are the Algiers dock, opposite New Orleans, La., and the steel dock taken by the United States government from Havana during the Spanish War, now in Pensacola, Fla. The Detroit dock and the Algiers dock are in fresh water, which makes preservation much easier.

Mr. A. C. Cunningham, Civil Engineer, U. S. Navy, in a letter discussing a paper suggested that it might be necessary to protect wooden pontoons against teredo attack on the bottom, and he instanced a case where a timber drydock at Boston, being filled for some time, had its keel blocks penetrated by the teredo to a depth of one inch. Mr. Donnelly, however, stated that he has examined many interiors of pontoons but has never found a trace of teredo action. He attributes this to the fact that no light enters, whereas in the case of the Boston dock the interior was exposed to some light.

Mr. Cunningham stated that a coal-tar paint has been found the best preservative for both the New Orleans dock (which is in fresh water) and the Pensacola dock (which is in salt water).

Prof. William Hovgaard presented a theoretical paper at the 1909 meeting dealing with the strength of the framing of water-tight bulkheads. Since then he has made some deflection tests of different bulkheads, and he reported them in a paper at the present meeting. The chief comparison which the results give is between bulkheads in which the vertical beams are wholly on one side of the plate and those in which the beam is in longitudinal halves with the plating between them and the whole riveted together through the plating. The later construction gave greater deflections in all cases, which the author attributes to rivet slip along the neutral axis. The bulkheads with beams wholly on one side and fitted at the ends with adequate bracket connections to produce fixity gave deflection curves practically identical with computed curves for the fixed-end condition.

In discussion, Professor Peabody made objection to the word "stiffener" which the author employed to designate the vertical bulkhead beams. He objected not because of the different meaning of the term "stiffener" in plate-girder practice, but because the erroneous impression might be obtained that the beams merely reinforce or stiffen the bulkhead, whereas they actually constitute its entire strength.

A detailed set of valuable comments on fire-prevention matters was given by Mr. S. D. McComb under the title "Some Suggestions for Reducing the Loss by Fire on Vessels." This paper led to animated discussion because a member of the New York Fire Department who had been invited for the purpose made rather pointed criticism of shipbuilders for not giving the same careful attention to fire prevention and fire protection that is current in city building practice. Numerous stout defenders of the shipbuilding profession replied, who extolled the highly fireproof character of first-class modern ships. President Taylor even went so far as to say that if he thought that one of the fine Sound steamers could burn up in transit in the way that vessels often burn up when laid up out of commission, he would leave the profession or commit suicide or do some other unheard-of thing. It seemed, however, that these defenders of shipbuilding had in mind mainly the most recent and most perfect steamships, while the fireman critic spoke of ships generally. Moreover, Mr. McComb then mentioned three Great Lakes freighters which burned up in transit during the last month or two.

Mr. Clinton H. Crane read a paper entitled "Comparative Results in Steam and Coal Consumption with Turbines, Reciprocating Engines, and a Combination of the Two on the Steam Yacht 'Vanadis.'" He was the designer of this vessel, which has a length of 279 ft. and a displacement of 1,300 tons. It was equipped with Parsons high-pressure and low-pressure turbines

three screws, for a guaranteed speed of 15½ knots maximum and a guaranteed consumption of 10 tons of coal per 24 hrs. at 13 knots cruising speed. The vessel in service and subsequently on thorough test in America showed a large excess of coal consumption over the guarantee, the maximum 24-hr. consumption at 13 knots being 33 tons, whereas the acceptance trial in England showed 13½ tons in 12 hrs. The high-pressure (middle) turbine was then replaced by a triple-expansion reciprocating engine, 18¾, 29 and 45 ins. × 26 ins. stroke, exhausting into the low-pressure turbines on the side shafts. This reduced the coal consumption by about one-third, to 22.7 tons in 24 hrs. at 13 knots. On steam-consumption the paper stated:

Apparently in the 13-knot condition, with the combination the propelling machinery is using about 14½ lbs. per indicated horsepower, the reciprocating engine alone about 17 lbs., and the turbines about 20½ lbs.

Some discussion followed in which poor coal was charged with being responsible for the high consumption of the turbines, and the words "picked Welsh coal" and "ordinary American coal" were placed in contrast. Mr. Crane replied that the coal used in the tests gave 9½ lbs. evaporation actual (and of course even higher from and at 212°), which he considers about as good as can be expected from good coal.

In "Coaling Warships; Notes of Progress" Mr. Spencer Miller (Lidgerwood Mfg. Co., New York) described a Marine Transfer for transferring coal from a collier to a warship. This transfer comprises a clam-shell bucket and such suspension ropes and rigging as will enable two steam winches to hoist the bucket out of the collier, swing it across to the hatch of the warship and then lower it. Such a transfer has handled 190 tons of coal in one hour. In discussion it was stated that the U. S. Naval collier "Cyclops" with a different type of transferring gear has transferred four tons per minute, or 24 tons per hour, and has handled 2,800 tons in a period of 12 hrs.

Two small vessels, respectively, 66 and 65 ft. long, built during the past season, were fitted with gas engines and gas producer. Mr. C. B. Page described their equipment in a paper entitled "Two Marine Installations of Producer Gas." The "Mary A. Sharp," of Chesapeake Bay, 66 × 14½ ft. × 5 ft. 3 ins., is equipped with a producer 4 ft. in diameter by 6 ft. 10 ins. high and a 75-HP. 3-cylinder engine 9 × 12 ins. The "Superior," of Bayfield, Wis., a fish collecting vessel, 65 ft. × 12 ft. 9 ins. × 4 ft. has a producer 3 ft. 6 ins. in diameter by 6 ft. 6 ins. high and a 50-HP. two-cylinder engine 9 × 12 ins. Together with the "Marenging" and the non-magnetic survey yacht "Carnegie," described at last year's meeting, the new vessels make a total of four American boats equipped with producer-gas machinery.

Mr. William W. Bates discussed the shipping question in a paper "Our Constitutional Shipping Policy and the Compact for Its Establishment," which was read by title. This was a historical review of the evidence leading up to the Act of 1828 which suspended ship protection in the foreign trade and which, in the author's words, is the act that has destroyed our marine.

"The Gyroscope for Marine Purposes," by Mr. Elmer A. Sperry, presented a rather general review of attempts to control the rolling of ships at sea, leading up to the Schlick application of the gyroscope for this purpose, now five or six years old. Further, it discusses what the author calls the active gyroscope as contrasted with Schlick's passive gyroscope. This active gyroscope involves anticipating the wave action and impressing upon the gyroscope a precessional motion before the roll has set up precession. Reference was made to recent experiments with gyroscopic apparatus at the Washington Navy Yard. The paper suggests also that Mr. Sperry has worked on the subject of adapting the gyroscope for use as a compass with electric transmission of the compass indication to various stations by the ship.

The author illustrated his presentation of the paper with an interesting demonstration of a gyroscope so mounted in an attachment to a long and heavy pendulum that the phenomena of passive and active checking of roll could be made clear.

A banquet at the Waldorf-Astoria Hotel on the evening of Nov. 18 closed the meeting.

A BROKEN RAIL wrecked an east-bound passenger train on the Chicago & Northwestern Ry. two miles west of Doland, S. Dak., Nov. 5. Three cars left the rails and were overturned, but no one was seriously hurt.

AN ELEVATOR CABLE BROKE, Nov. 18, in a store building at 118 Sixth Ave., New York City. The two men in the elevator were killed. It is reported that the cable gave way while one of the men was attempting to start the car downward from the third floor.

TYPHOID FEVER AT THE U. S. NAVAL ACADEMY at Annapolis has assumed almost epidemic form, there being 21 cases in the cadet hospital on Nov. 22. Medical officers at the academy report that they consider the cause to be an additional milk supply which was started some three weeks ago to help out the regular supply.

THE FLOODS AT PARIS during the past week reached a height of 31.6 m. on the Pont Royal, but had, by Nov. 22, commenced to fall. According to the relative elevation established in the floods of last winter, this height on the Pont Royal should mean a flood elevation of about 32.5 m. on the Pont de la Tourville, which is about 2.2 m. lower than the maximum flood height of last winter.

THE STEAMERS "LA LORRAINE" AND "PRINZ Friedrich Wilhelm" collided, Nov. 17, in the Hudson River, New York City, as they were starting on the voyage to Europe. The collision occurred while the "Prinz Friedrich Wilhelm" was backing out from her pier, and the "Lorraine" was headed down-stream. The prow of the French line vessel struck the stern of the North German Lloyd liner. Large holes were made in the bows of both vessels above the water line, and they were obliged to return to their piers.

ANOTHER TALL TOWER BUILDING is to be added to those already in New York City, according to the plans for the new Woolworth Building now in process of construction at the southwest corner of Broadway and Park Place. This structure is to have a main part 26 stories high, with a tower extending 19 stories farther to a total height of 625 ft. The Metropolitan tower, at 23d St. and Madison Ave., has a total height of 700 ft. and the Singer Tower, at Broadway and Liberty St., 612 ft. These three are the tallest buildings in the world used for living or office purposes.

A LOCOMOTIVE BOILER EXPLODED Nov. 18 on the Texas & Pacific Ry., near Texarkana, Tex., while hauling a freight train. The engineer and fireman were killed.

The boiler of a locomotive which was being used as a pusher on the rear of a freight train on the Pennsylvania R. R. exploded Nov. 19 near the city limits of Altoona, Pa. The explosion occurred just as an express train, running in the same direction as the freight, came by on the next track. The two locomotives of the express train were derailed by the exploded boiler and were thrown against the freight train, wrecking several cars. Three men were killed. The accident is ascribed to low water in the boiler.

THE BREECH BLOCK OF A 5-IN. GUN was blown out Nov. 19 at the proving grounds of the U. S. Navy at Indianhead, Md. The accident was very similar to the one which occurred at Fort Monroe, Va., last summer. The firing pin projected in such a way that when the breech block was closed it struck the pin and caused the charge to be fired. The breech block was blown back into the firing crew, and four of the men were killed. According to the press reports, the only precaution against such accidents as the guns are now constructed is the vigilance of the gun captain in detecting any improper projection of the firing pin.

THE COAL-CARRIER "BERWINDMOOR" has been received from its English builders, Sir Raylton Dixon & Co., of Middlebrough, and is about to begin service between Havana and Atlantic ports. The principal particulars of the vessel are:

Length, over all	425 ft.
Breadth	54
Depth	29
Draft, loaded	24½
Capacity, gross tons	8,625
Engine, triple expansion	28, 46 & 77 × 48 ins.
Power at 92 r. p. m.	3,900 HP.
Speed at 92 r. p. m.	14½ knots
Boilers (3), 3 furnaces each	15¼ × 11½ ft.

The framing is of the Harroway-Dixon cantilever frame type, with ballast tanks in the triangular portion at the tops of the sides. The hold is divided by transverse bulkheads into five main holds, ranging from 37,770 to 105,440 cu. ft. capacity, giving with the poop hold a capacity of 410,040 cu. ft. Eight hatches, 21 × 33 ft., expose a large part of the length of the holds for discharging by grab-bucket. On account of the arrangement of the hold space the boiler and engine rooms are in the extreme stern, and whistle and steering-gear are operated electrically from the bridge. The ship lacks the naval masts, but instead has four portal frames or pairs of braced steel pillars extending above the deck, to which the derrick booms are attached. These portals also carry short signal spars and the supports for the wireless aerial.

A SCHEME FOR REDUCING THE COST of constructing subway in New York City has been submitted to the Public Service Commission by the Concrete Interlocking Steel Corporation of New York City. This company claims that by the use of its plans the outline section and route of the subway as planned and bid upon (Engineering News, Nov. 3, 1910) can be utilized and that a very considerable sum, some $25,000,000, can be saved to the city. The plan contemplates a provision for a four-track subway, two express tracks below in a single arched tunnel section, and the two local tracks above, each in a separate arched tunnel, all of the same size section as in the present plans. Instead of the structural steel column and girder construction with concrete roof, provided by the present plans, a concrete section is designed in which the side walls are plain concrete and the arch reinforced in two planes, at extrados and at intrados, respectively, by the corrugated steel plates invented by Du Mazuel.

The main point of novelty in the design is the method of construction, which follows closely the latest sections of the Paris Metropolitan and the London subways. Every 10 ft. there is to be erected a steel frame composed of angles following the outer and inner lines of the concrete section and joined together by lattice bars. Between these frames the corrugated steel plates are to be laid on the faces of the angles forming a complete box, enclosing the tunnel section for the 10-ft. length. Into this box is then to be pumped, either by screw pumps or by compressed air, the concrete which forms the tunnel section. The outside and the inside of the corrugated steel are then to be plastered with cement mortar, and the top filling of earth placed. If the section is in tunnel cut, concrete will be pumped into the void above the forms.

The saving is claimed on account of the lower cost of concrete than steel and because of the great reduction in the labor cost of pumping concrete between forms which are a necessary part of the structure.

The plan calls for the same type of construction at stations as that proposed by the Public Service Commission.

BY THE FALL OF AN AEROPLANE Ralph Johnstone, an aviator employed by the Wright Company, was killed at Denver, Colo., on Nov. 17. He had ascended to about 800 ft. and was descending in a series of small circles when the left wing tips gave way and destroyed the equilibrium of the machine. During the first seconds of fall the aviator attempted in vain to regain control by warping the right wing tips. It is reported that the crowd on the aviation field made a disgraceful scramble for bits of wreckage as souvenirs, before police or doctors could reach the machine. The accident is reported to have been the result of the aviator's foolhardiness or carelessness as the machine had been damaged previously that same day.

THE UNITED STATES POST-OFFICE DEPARTMENT, on Nov. 21, arrested, on the charge of using the mails to swindle investors, several of the officers of Burr Brothers, Flat Iron Building, New York City, and of the Continental Wireless Co., 56 Pine St., New York City. Those arrested were put in prison in default of $10,000 bail. According to the statement issued by the post-office inspectors at the time of the arrest, these concerns have sold stock all over the country in a large number of companies which have either never done any business at all or have made only a pretense of carrying on business. The stock was widely advertised in the newspapers. The companies organized include oil companies, mining companies and concerns to exploit inventions. Among the companies exploited by Burr Bros. which attracted most attention were the Coalinga Consolidated Oil Co., capitalized at $1,000,000; Coalinga Crude Oil Co., capitalized at $4,000,000; Rawhide Tarantula Mining Co., capitalized at $1,000,000; Golden Fleece Mining, Milling & Refining Co., $300,000; California Eucalyptus Timber Co., $1,000,000; Nevada Gold Field Mining, Milling & Smelting Co. $5,000,000; Cobalt-Portage Mine Co., $1,000,000; British-American Copper Mines & Smelter Co., $5,000,000; Holcomb Automatic Engine Co., $500,000; Yukon Basin Gold Dredging Co. $1,000,000; Toledo, Wabash & St. Louis R. R., $6,000,000; Chicago-New York Electric Air Line R. R., $2,000,000; Co-operative Construction Co., $1,000,000.

The Post-Office Department estimates that Burr Broth-

ers and their associates have disposed of stock of a par value of from $40,000,000 to $50,000,000 in various companies. In every instance they have held out the promise of large dividends to be paid upon the stock with prospect of increase in value, but none of the companies have ever paid a dividend and most of them are now out of existence.

The Continental Wireless Telephone & Telegraph Co. was ostensibly a concern to act as a holding company for four other wireless companies, the Collins, the Pacific, the Clark and the Massie. These various smaller companies also appear to have been practically swindles. The Collins Co., for example, sold its stock to "fiscal agents" at 20 cts. a share, and these agents raised the price of the stock at various times to $10. The fraud in connection with the promotion of these various companies was so notorious that some of the inventors which had in good faith begun dealings with them were obliged to repudiate all connection with them.

The Post-Office Department states that the former practice of merely issuing fraud orders against swindling concerns is no longer to be followed, but that such fraudulent enterprises will be followed up and those concerned in them will be made to feel the penalty of the law.

THE MISSISSIPPI RIVER BRIDGE at St. Louis, known as the McKinley Bridge, and built for the electric railway service of the Illinois Traction System, was formally opened to traffic on Nov. 10. The bridge has three through-truss double-track channel spans of 500 ft., five deck-truss shore spans of 150 and 250 ft. and large viaduct approaches. The total length is about 1½ miles. Roadways are carried outside of the trusses by cantilever floorbeams. From the St. Louis end of the bridge the cars run through the streets to a large passenger station and freight terminal near the center of the city. The St. Louis Electric Bridge Co. was organized as subsidiary to the electric railway company, and Mr. Ralph Modjeski, M. Am. Soc. C. E., of Chicago, was the engineer. The steel work was built by the Pennsylvania Steel Co. The substructure work and the erection of the superstructure was done by the Missouri Valley Bridge & Iron Co. The bridge was described and illustrated very fully in our issues of Jan. 6 and July 28.

A CONCRETE BUILDING under construction at Lorain Ave. and W. 30th St., Cleveland, O., collapsed on Nov. 21, the walls falling on a small frame house next door and killing four people who were there. The collapse came at night, while no work was going on in the building. As yet the cause of the failure has not been reported.

Personals.

Mr. F. G. Bolles, Assoc. Am. Soc. M. E., Commercial Engineer of the Allis-Chalmers Co., has resigned to become associated with the Reliance Engineering & Equipment Co., of Milwaukee, Wis.

Mr. L. W. Berry, formerly Superintendent of the Lehigh & Hudson River Ry., at Warwick, N. Y., has been appointed Superintendent of the New York & Long Branch R. R. at Long Branch N. J.

Mr. Walter Brinton, formerly Superintendent of the Manganese Steel Department of the Taylor Iron & Steel Co. at High Bridge, N. J., has become Consulting Engineer for the Edgar Allen American Manganese Steel Co. at New Castle, Del.

Mr. A. P. Prendergast, formerly Master Mechanic of the Baltimore & Ohio R. R. at Mount Clare, Baltimore, Md., has been promoted to Superintendent of Motive Power of the Baltimore & Ohio Southwestern R. R., at Cincinnati, Ohio, succeeding Mr. John Hair, who has resigned.

Dr. H. Monroe Hopkins, Assoc. Am. Inst. E. E., formerly Professor of Electro-Chemistry at George Washington University, Washington, D. C., has been made the head of the Division of Electrical Engineering of the Institute of Industrial Research. This is a testing laboratory which has been established in Washington, D. C. by Dr. A. S. Cushman, as noted in our personal columns of last week. The Division of Paint Technology will be in charge of Mr. Henry A. Gardner, recently Director of the Scientific Section of the Paint Manufacturers' Association of the United States.

Obituary.

Mrs. W. Kendrick Hatt, wife of Prof. Hatt, of Purdue University, died on Nov. 17, at Lafayette, Ind.

Frederick B. Childs, Master Mechanic of the Northern Pacific Ry. at Spokane, Wash., died recently from apoplexy, aged 46 years. He was formerly with the Great Northern Ry.

Samuel E. Hathaway, General Superintendent of the Fall River Iron Works Co., died at his home on Nov. 16. He had been with this company since 1889. He was 45 years old and leaves a widow and two children.

Frank Grundy, President of the Temiscouata Ry. and Vice-President of the Quebec Central Ry., died at his home in Sherbrooke, Que., on Nov. 14, at the age of 74 years. He was born in Lancashire, England, and began his railway work in 1850 as a clerk on the Manchester, Sheffield & Lincolnshire Ry. He was appointed General Manager of the Quebec Central Ry. in 1889.

Engineering Societies.

COMING MEETINGS.

NEW JERSEY SANITARY ASSOCIATION.
Dec. 2-3. Annual meeting at Lakewood, N. J. Secy., J. A. Exton, 75 Beech St., Arlington, N. J.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 5-6. Annual meeting at New York City. Secy., W. H. Rose, 154 Nassau St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 6-9. Annual meeting at New York City. Secy., C. W. Rice, 29 West 39th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 7-9. Annual meeting at New York City. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

ASSOCIATION OF AMERICAN PORTLAND CEMENT MANUFACTURERS.
Dec. 12-14. Annual convention at New York City. Secy., Percy H. Wilson, Land Title Bldg., Philadelphia, Pa.

NATIONAL ASSOCIATION OF CEMENT USERS.
Dec. 12-17. Annual convention at New York City. President, Richard L. Humphrey, Harrison Bldg., Philadelphia.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27. Annual meeting at St. Paul, Minn. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-28. Annual meeting at Lafayette, Ind. Secy., E. W. Hamilton, Iowa State College, Ames, Iowa.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 2-6. Annual meeting at Winnipeg, Man. Secy., C. H. McLeod, 413 West Dorchester St., Montreal, Que.

INDIANA ENGINEERING SOCIETY.
Jan. 12-14. Annual meeting at Indianapolis, Ind. Secy., Charles Brossmann, Indianapolis, Ind.

MONTANA SOCIETY OF ENGINEERS.
Jan. 12-14. Annual meeting at Helena, Mont. Secy., Clinton H. Moore, Leyson Block, Butte, Mont.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 17. Annual meeting at Pittsburg, Pa. Secy., Elmer K. Hiles, 803 Fulton Bldg., Pittsburg, Pa.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting of Nov. 11, Mr. Mont Schuyler, Engineer in charge of the City Testing Laboratory of St. Louis, presented a paper entitled "Certain Theoretical Aspects of Specifications."

CANADIAN SOCIETY OF CIVIL ENGINEERS.—At a meeting of the mining section at Montreal, Que., Nov. 24, Mr. Hilder Daw is to deliver an illustrated lecture on "Railway Construction and Tropical Experiences in the Gold Mines of Ashanti, West Africa."

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.—The annual meeting was held at Springfield, Ohio, Nov. 18-19. Papers were presented on "Automatic Smokeless Furnaces and Smoke Repression," by M. C. Huyette; "The Smoke Situation in General," by Geo. R. Bott, and "Vapor Heating Systems," by Thomas Mouat.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—A tentative program has been announced for the 32d annual meeting, Dec. 6-9, in New York City. Five professional sessions are planned, all of which will be held on Wednesday and Thursday, leaving Friday free for excursions and entertainments.

The reception by the local membership will be held Wednesday evening instead of Thursday as heretofore. The papers to be presented are as follows:

Dec. 7. Morning—"The Joint Meeting in England," Calvin W. Rice, New York City; "The Transmission of Heat in Surface Condensation," Geo. A. Orrok, New York City. Afternoon—"Combustion and Boiler Efficiency," Edward A. Uehling, Passaic, N. J.; "Automatic Control of Condensing Water," B. Viola, Brooklyn, N. Y.; "Test of a 10,000-KW. Steam Turbine," Samuel L. Naphtaly, San Francisco, Cal.; "Test of a 9,000-KW. Turbo-Generator Set," F. H. Varney, San Francisco, Cal.; "Notes on the Value of Napier's Coefficient With Superheated Steam," Isaac Harter, Jr., Barberton, Ohio.

Dec. 8. Morning—"A New Theory of Belt Driving," Selby Haar; "Stresses in Connecting Rods," W. H. Herschel; "Operating Conditions of Passenger Elevators," R. P. Bolton, New York City; "Modern Shoe Manufacture," M. B. Kaven and J. B. Hadaway, Beverly, Mass. Afternoon—Simultaneous sessions of machine shop and gas power sections: "The Field for Grinding," C. H. Norton, Worcester, Mass.; "Precision Grinding," W. A. Viall, Providence, R. I.; "Modern Grinding Methods," B. M. W. Hanson, Hartford, Conn.; "First Large Gas Engine Installation in American Steel Works," E. P. Coleman, Buffalo, N. Y.; other gas power papers to be assigned. Evening—"Industrial Continuation Schools of Munich," Dr. Georg Kerschensteiner, Superintendent of Schools, Munich, Bavaria.

NATIONAL ASSOCIATION OF CEMENT USERS.—The following tentative list of papers has been announced for the seventh annual convention to be held at Madison Square Garden, New York City, Dec. 12-17, 1910. In addition to the papers named below, there are the usual formal addresses, discussions and committee reports scheduled:

Dustless Concrete Floors, L. C. Wason; Some New Methods in Sidewalk, Curb and Gutter Construction, J. B. Landfield; Web Reinforcement of Concrete Beams, Peter Gillespie; Web Reinforcement of Concrete Beams, Major John Stephen Sewell; Flat Slabs of Reinforced Concrete, Arthur N. Talbot; Discussion of Flat Reinforced Concrete Plates, Angus B. MacMillan; Analysis of Results of Load Tests on Panels of Reinforced-Concrete Buildings, Emile G. Perrot; A Comparison of the Concrete Industry in Europe and America, Dr. Otto Schott; The National Fire Protection Association and Its Work, Chas. H. Merrill; Some Thermal Properties of Concrete, Prof. Charles L. Norton; An Incident of Value of Concrete in Reducing Cost of Insurance, Emile G. Perrot; Effect of Electrolysis on Metal Embedded in Concrete, Cloyd M. Chapman; Construction Problems of the Aziscohos Concrete Gravity Dam, Seth A. Moulton; Preparation and Handling of Concrete, H. M. Cryder; Advantages and Comparative Cost of Spouting Concrete, F. E. Engstrum; The Use of Compressed Air in the Handling of Mortars and Concrete, G. L. Prentiss; General Considerations in the Construction of a Cement Products Plant, Charles D. Watson; Cement Tile Plant—Layout and Operation, C. M. Powell; Additional Notes on Steam Curing Plants, F. S. Phipps; Comparative Cost and Maintenance of Various Types of Building Construction, J. P. H. Perry; Concrete Filled Arches, H. H. Quimby; Reinforced-Concrete Sewers, J. A. Hooke; The Hudson Memorial Bridge, William H. Burr; Reinforced Concrete Construction in San Francisco and Vicinity, John H. Leonard; Reinforced-Concrete School Buildings, John T. Simpson; The Use of Reinforced Concrete for Hospitals and Similar Structures, R. A. McCullough; Advantages of Reinforced Concrete for Farm Buildings, Alfred Hopkins; The Advantages of Admixtures of Tufa to Portland Cement, J. B. Lippincott; Use of Reinforced Concrete in Sea-Water, R. Baffrey; The Relation of the Lime Contents of Cement to Durability of Concrete, Henry S. Spackman; The Insulation of Concrete Structures, Edward W. DeKnight; The Waterproofing of Tunnels, A. H. Harrison; Waterproofing with Water, Cloyd M. Chapman.

WESTERN SOCIETY OF ENGINEERS.—An excursion was made on Nov. 16, by special train, to the extensive limestone quarry and stone crushing and screening plant of the Dolese & Shepard Co. at Gary, Ill. The train left the Union Station at 1.30 p. m., making one stop at Hawthorne. Here the party visited the company's hydrated lime plant, the monolithic concrete plant of the Unit Construction Co. and also saw a blast in the Hawthorne quarry.

The crushed stone plant at Gary, Ill., is said to be the largest in the world. It was described at some length in our issue of Oct. 21, 1909, and copies of this article (in pamphlet form) were distributed to the visitors. The output at present is about 4,000 to 5,000 cu. yds. per 9-hour day, but the plant is equipped with electric lights, signal lamps, etc., to permit of working 20 hours per day. Two special features of the plant are (1) the almost exclusive use of electric power, and (2) the use of an electric haulage system employing motor dump cars whose movements are all controlled from a cabin overlooking the quarry. When the plant was first started, electrically operated 110-ton shovels were used to load the broken rock into the quarry cars. These did not prove entirely satisfactory, however, especially in speed of working, and the work is now done by four 110-ton Bucyrus steam shovels. There is very little stripping, and the quarry is being enlarged by sinking large blast holes with well-drilling rigs.

The loaded quarry cars run automatically to the main crusher house, the weight being taken and recorded automatically on the way. The stone is dumped into the hopper of a McCully gyratory crusher of the largest size made, driven by rope transmission from a 250-HP. motor. The 6-in. product is delivered to two pan conveyors which discharge it into a bin feeding two Gates gyratory crushers, the product from which goes to four revolving screens. The stone is sent to further crushing apparatus or returned for recrushing. The additional crushers include eight of the Gates gyratory type and two of the roll type. The sizes, ranging from 6-in. to screenings are delivered to reinforced-concrete storage bins, beneath which are tracks for railway cars. The stone is discharged into the cars through pneumatically operated gates, and 75 cars can be loaded in an hour.

Beyond the last crushing house is an experimental plant for washing screenings, and producing a very fine and clean product which may be used instead of sand in concrete work. This will eliminate the objections often made to the use of screenings (for certain kinds of work) on the ground of the amount of dust and dirt which is mixed with ordinary screenings.

A meeting was held at the Society's rooms in the evening, at which there was a general discussion of the special features of the plant.